is capable of an average speed of 7½ knots under favorable conditions. The average annual cost for repairs during the last ten years has been $2,160 (£442)—a total of $21,600 (£4,420), or 34 percent of the original cost. About $2,000 (£410) will be required for repairs at the end of the present season.

Apart from the unfitness of these vessels for their work and from the danger of operating them in heavy weather, another feature which militates against their continuance in service is the costly waste of time which results from a lack of funds for their operation. On account of their slow speed and the impossibility of staying at sea in any but moderate weather, their actual output is reduced by nearly 20 percent. Furthermore, as the Coast and Geodetic Survey is not provided with sufficient funds to keep the vessels in service continually, the *McArthur,* for instance, was idle for 25 percent of the last fiscal year, the *Gedney* was idle for three months from lack of funds, and the other ships have suffered accordingly.

It is proposed to replace these vessels with seaworthy steamers 130 feet long, of about 500 gross tons, driven by twin screws actuated by compound engines supplied with steam from watertube oil-burning boilers, and fitted with electricity for wireless signals, lights and complete auxiliaries, including a refrigerating plant. Comfortable and sanitary quarters and sufficient working space will be provided for the crews and officers. Such vessels would be able to go on cruises of six or seven months' duration in places remote from settled regions, and they could carry an outfit capable of meeting emergencies. As an appropriation of only $500,000 (£102,500) is being asked for these new vessels, Congress should speedily make the necessary appropriation to meet this imperative need.

Electrical Propulsion on Battleships

The confidence evidenced by the Navy Department in the future of electrical propulsion as applied to battleships apparently is well founded when it is known that in the case of the naval collier *Jupiter,* where the installation of electric drive proved entirely successful, the builders of the machinery themselves did not wholly approve of this installation; for, while they were absolutely confident of its success, they knew that such an installation did not offer the possibilities for demonstrating the special advantages of electrical drive to such an extent as would be the case on a battleship. The *Jupiter* was a one-speed boat; that is, she was designed for economical operation at a single speed, whereas, in the case of a battleship, it is of great importance that the machinery shall operate economically at a slow or cruising speed and, at the same time, be capable of operating at full speed with the best possible economy. With electric it will be possible to get the same, or even better, a cruising speed of, say, 12 knots as at the full 0½ knots, whereas in a direct turbine-driven best economy which is obtained at full speed maintained at cruising speeds.

A splendid opportunity for comparison will be offered between the *California,* fitted with electric drive, and the *Pennsylvania,* fitted with direct connected turbines and geared cruising turbines. On the *Pennsylvania* an efficiency of about 61 percent will probably be obtained, the propellers turning at 220 revolutions per minute, while on the *California* an efficiency as high as 75 percent is confidently expected, the revolutions of the propellers being only 160 per minute. The slower turning propellers will offer an opportunity to regain a part of the losses in the electrical transmission on account of the increased efficiency of the slow-running propellers. The claims of 75 percent, and even more, for the efficiency of electric drive, are founded on results already obtained with similar machinery in shore installations, and are very favorable as compared with the figures for the efficiency of direct turbine drive as already obtained from the operation of such vessels as the *Lusitania* and a number of naval vessels where an efficiency of 63 percent was obtained.

One of the first points to be considered in the installation of electric drive is its reliability. On a battleship the machinery will consist of two turbo generators running at a maximum speed of about 2,000 revolutions, generating current at about 3,000 volts, and four induction motors of the double squirrel cage type arranged on four shafts. The stators of the motors will be fitted with pole changers which will give the motors two different numbers of poles, and, consequently, two speed reductions. In such an installation, reliability is gained from the fact that the installation is in duplicate and the breakdown of one engine does not affect the ship except at high speeds. With only one turbo generator in operation the ship can run in a perfectly normal manner with normal efficiency up to a speed of about 19 knots. As pointed out by Mr. W. L. R. Emmet in the discussion of the paper on electrical propulsion presented at the naval architects' meeting, electrical machinery is not exactly a unit, it is a collection or combination of various parts, so arranged that it is practically impossible for the entire installation of machinery to be completely wrecked. Under intelligent care the generator can be made to run even if many things happen to it. Reliability is also gained from the fact that the turbines always operate in one direction and the danger of blading trouble is thereby reduced to a minimum. There is also a gain in efficiency in backing, whereas in any other form of drive losses are bound to occur in reversing the engines. According to Mr. Emmet, gains in economy are also possible with the electric drive by improvement in the operation of the auxiliaries. Although the auxiliaries in the electric-driven *Jupiter* proved more economical than those in her sister ships, the steam consumption for the auxiliaries was, nevertheless, far beyond reason. To improve these conditions on a battleship installation it is proposed to install a turbine-driven exciter of large enough capacity to furnish the current for operating the auxiliaries, and thereby materially reduce the water rate of the auxiliaries.

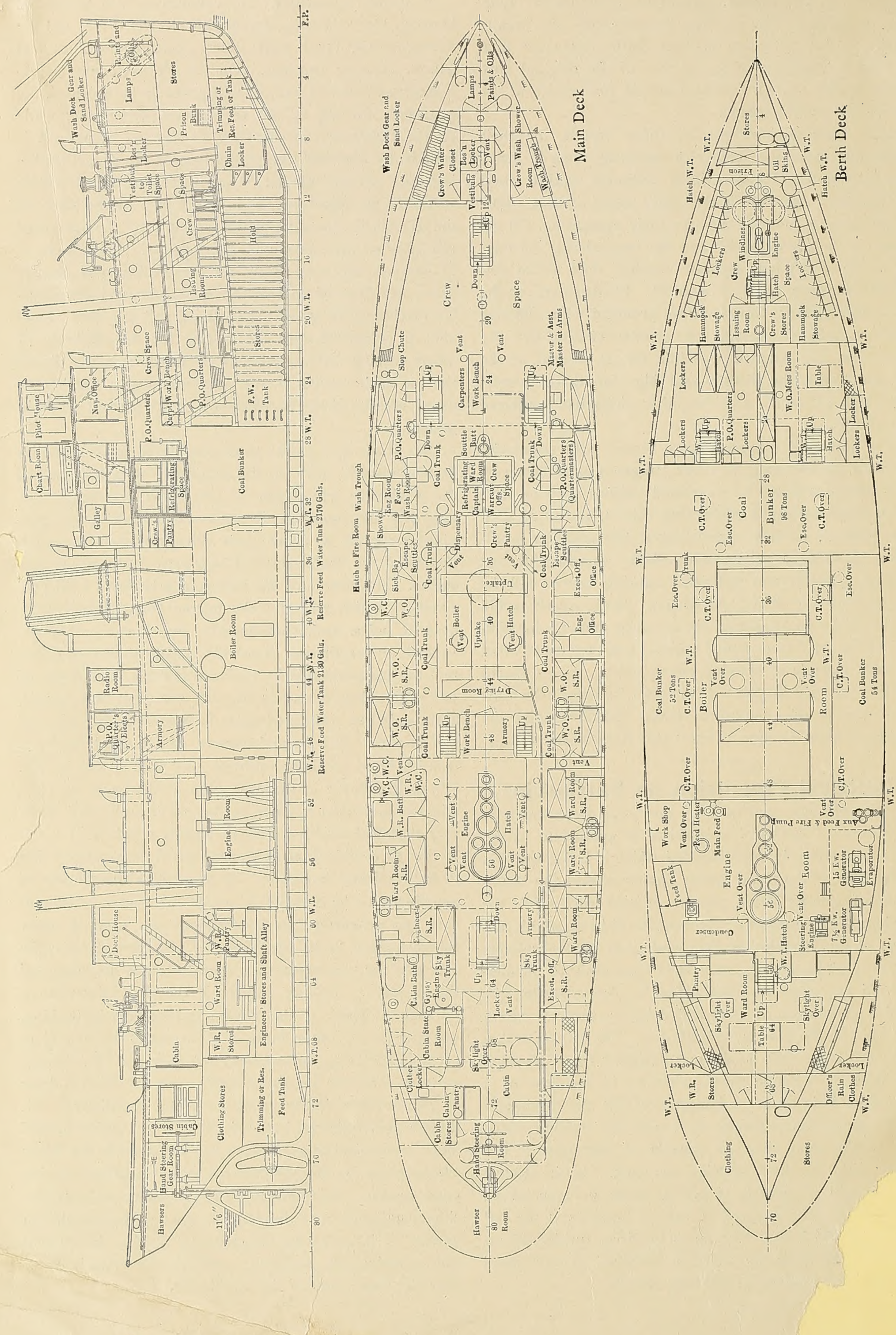


Fig. 1.—Profile and Deck Plans of New Revenue Cutters Building at Newport News

New United States Revenue Cutters

Description of the Hull and Machinery of the Latest Revenue Cutters Now Under Construction at Newport News

The two new United States revenue cutters now being built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., are sister ships, each 165 feet 6 inches long overall, 150 feet long between perpendiculars, 32 feet beam molded, with a depth of 20 feet 9 inches. Their displacement at a mean draft of 11 feet 6 inches, with 200 tons of coal, 13,000 gallons of fresh water and 12 tons of stores on board will be 900 tons. They are of the flush deck type, with the schooner rig, and accommodations are provided for eight officers and a crew of sixty men.

One of the vessels has been designed to replace the revenue cutter *Woodbury,* stationed at Portland, Me., and the other to replace the old cutter *Winona,* now stationed at Mobile, Ala. The only difference between the two ships is that the cutter for service on the coast of Maine will be especially fitted for breaking ice in the harbors and along the coast of Maine. Both vessels will be fitted with every modern means of rendering aid to vessels in distress, of destroying derelicts and for other purposes of the revenue cutter service.

General Arrangement

The hull of each vessel is subdivided by 7 watertight bulkheads, all of which, with the exception of two just aft of the forward collision bulkhead, extend to the upper deck. There are three decks, designated as the upper deck, main deck and berth deck. The upper deck is a flush deck and on it amidships is a steel deck house containing at the forward end the navigating office, over which are the pilot house and chart room. Aft of the navigating office is the galley and radio room, with the petty officers' quarters arranged just forward of the engine room hatch. The main companionway is in an after deck house.

On the main deck forward are the lamp and paint rooms, the boatswain's locker and then the crew spaces. Aft of the crew spaces are quarters for the petty officers and a refrigerating room, immediately aft of which is the crew's pantry. The main cabin is aft on this deck, while the quarters for the officers are alongside the engine and boiler hatches.

On the berth deck forward is a storeroom and the ship's prison. Aft of this is space for the crew, and still aft of this on the port side, quarters for the petty officers, and on the starboard side the warrant officers' mess. The machinery space is taken up first by an athwartship coal bunker of 98 tons capacity, then the boiler room with wing bunkers on each side, after which is the engine room and then the ward room, and finally space for stores.

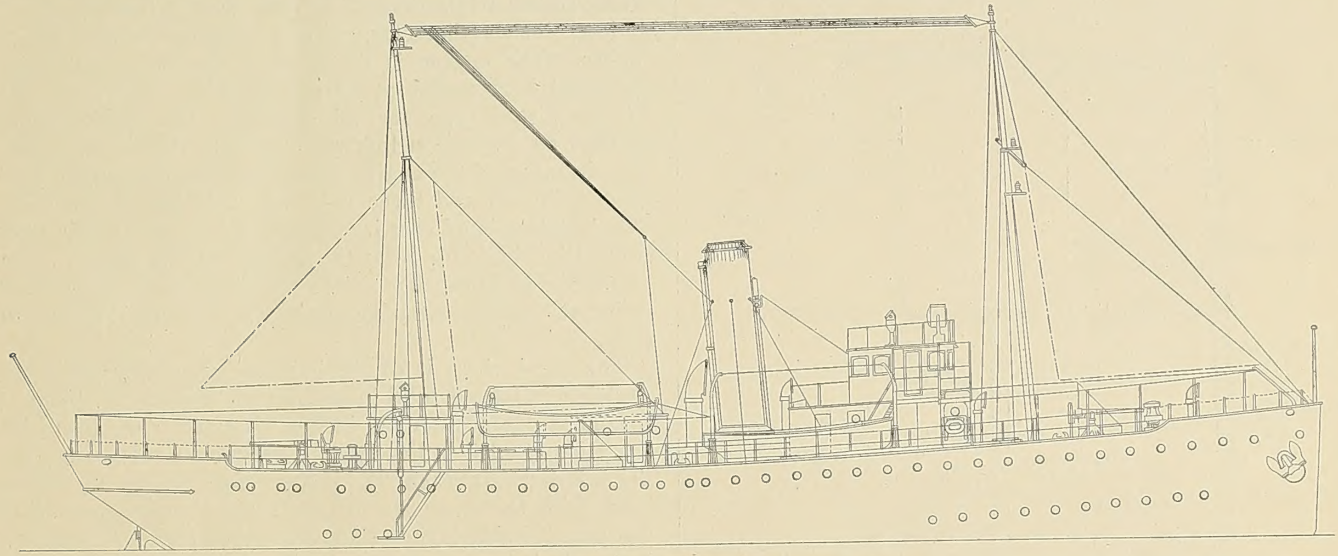


Fig. 2.—Outboard Profile of the New Revenue Cutters

Hull Construction

The stem is of cast steel in two parts, webs being worked inside the castings to take the keel, floors and decks. The stern frame, consisting of the propeller post and rudder post and the parts between them forming the counter and shoe, is a steel forging, the propeller post being 6½ inches wide by 4 inches thick, and the rudder post of the same size, pear-shaped on the forward side and provided with stops to prevent the rudder from swinging more than 40 degrees each side of the centerline.

The rudder is of the double plate type, the frame being forged solid in one piece, covered with 12-pound plates riveted through the frame and calked.

The frames are 4 inches by 3 inches by 8.5 pounds angles, joggled at the outside plating laps to avoid the use of liners at the frames. In the bow the frames are spaced 16 inches and throughout the rest of the vessel 24 inches apart. The frames in general are continuous from the keel to the under side of the upper deck plating. The reverse frames are 3 inches by 3 inches by 7.2 pound angles for a half length amidships, reduced to 3 inches by 3 inches by 6.1 pounds at the ends. The reverse frames in the boiler room bilges, however, are increased to 3½ inches by 3 inches by 7.9 pounds. Forward of frame 8 the reverse frames were run to the main deck beam brackets, except on every third frame they will run to the under side of the upper deck beams. Abaft frame 8 the odd-numbered reverse frames will run to the main deck

brackets and the even-numbered reverse frames to the upper deck beams.

The floors for half length amidships will be 16-pound plates reduced to 14 pounds at the ends, while in the boiler room and bilges inboard of the coal bunker bulkheads and not in reserve feed water tanks, the floors will be 20-pound plates. In the engine room, they will be 18-pound plates. In general, the floors are 22 inches depth at the throat.

Web frames will be located in the bunker and engine spaces as shown on the plans. The frame angles will be single 4 inches by 3 inches by 8.5 pounds, and the inner

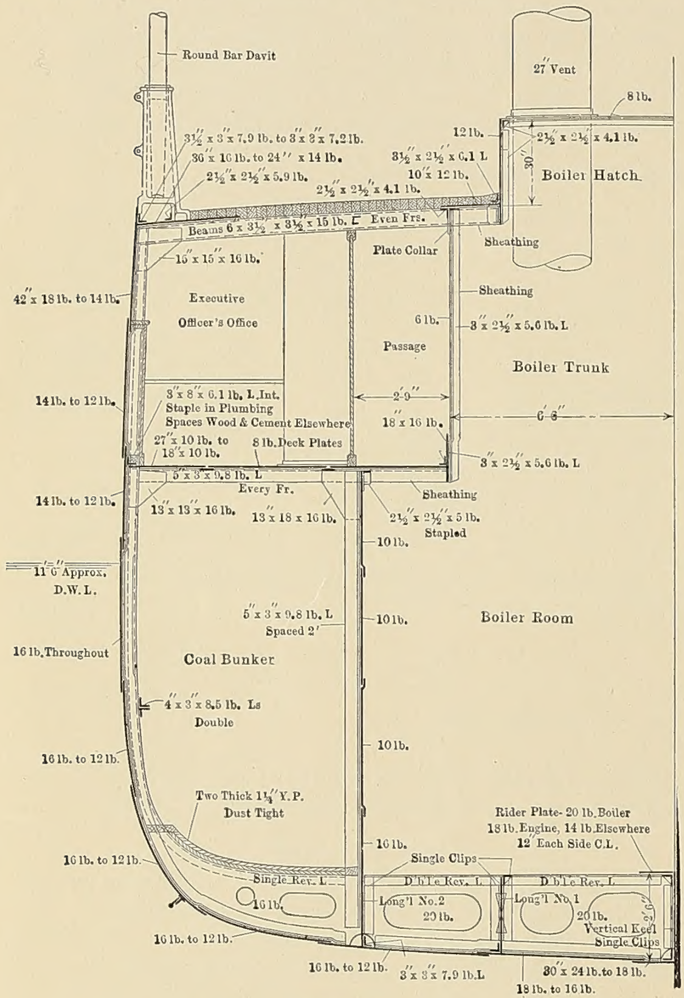


Fig. 3.—Midship Section

angle will also be single of the same size, the plate being of 16 pounds, 14 inches depth. The web frames extend from the coal bunker bulkhead or vertical keel, as the case may be, to the under side of the main deck.

In addition to the vertical keel there are two longitudinals on each side of the keel. The plating of the first longitudinal is 20 pounds in the boiler room, 18 pounds in the engine room and 14 pounds elsewhere. The longitudinal is continuous in wake of the fresh water tanks and throughout the boiler room. Elsewhere the plating is intercostal. The angles of the longitudinal are as shown in the midship section. The second longitudinal is worked as a continuation of the fore and aft coal bunker bulkheads and is of 14-pound plate worked intercostal.

The vertical keel, which extends from frame 4 to 69, is in general 26 inches deep, although increased in depth in the boiler and engine room. The outer angles are double 3½ inches by 3½ by 8.5 pounds continuous throughout. The inner angles are of the same size, continuous between frames 32 and 60, and the boiler and engine rooms. The vertical keel plates are 20 pounds in the boiler room and 18 pounds in the engine room, reduced in steps to 14 pounds at the ends.

The shell plating is worked in in and out strakes of the weights shown on the midship sections. The watertight bulkheads are built in horizontal strakes and stiffened by vertical angles spaced 24 inches apart. In the collision bulkheads the lower strake is 14-pound plating, above which is 12-pound plating to the main deck, while above that the plating is 10 pounds. Other transverse bulkheads below the main deck have the lower strake of 14 pounds and all strakes above 10-pound plating, except that the lowest strake of coal bunker bulkheads will be 16-pound plating.

Propelling Machinery

The main engine is of the vertical inverted cylinder direct-acting triple expansion type with cylinders 17, 27 and 44 inches diameter, with a common stroke of 30 inches. The engine is designed to develop about 1,000 indicated horsepower at normal speed. The valves are of the piston type for all cylinders, the valves being worked by Stevenson link motions with double bar links. The framing of the engine consists of three wrought steel front columns and three cast iron columns at the back. The bedplate is of cast iron supported on a wrought steel foundation built up from the frames of the vessel. The crank line and propeller shafts, the piston rods, connecting rods and working parts generally are of mild open-hearth steel.

The crank shaft is of the built-up type, while all other shafting is forged solid in one piece. The thrust shaft is forged in one section 8¾ inches diameter. The propeller shaft is 9½ inches diameter. There are six bearings for the crank shaft, each 8¾ inches diameter by 10 inches long, with the exception of the after low-pressure bearing, which is 8¾ inches diameter and 12 inches long. The stern tube is in one section with bearings at each end of the tube. The after bearing is 3 feet long and the forward bearing 2 feet long. The propeller is of cast steel with four blades of the built-up type, the diameter being about 10 feet 6 inches.

The engine is fitted with a reversing gear consisting of a steam cylinder 9 inches in diameter and 16 inches stroke, secured to the back side of the high-pressure back column. A turning gear is fitted to the crank shaft of the engine for turning it by hand.

The condenser is made with a cast iron shell ⅝ inch thick, 7 feet 3⅛ inches long between tube sheets and 3 feet 6 inches inside diameter. The condenser tube sheets are of rolled bronze, 1 inch thick, and there will be about 1,112 seamless drawn condenser tubes ⅝ inch outside diameter No. 18 U. S. S. G. thick, and 6 feet 8 inches long inside of the tube sheets, forming a cooling surface of about 1,328 square feet.

A combined feed and filter tank with a capacity of about 300 gallons is placed in the engine room, as shown on the general plans, and so arranged that the water from the air pump will be discharged at the top and then filtered successively through the divisions in the tank from the top, so that the filtering material will be readily accessible. A feed water heater, using auxiliary exhaust steam, is also installed in the engine room.

The pumps installed in each ship include the following:

One main circulating, vertical centrifugal, 24-inch runner, 5-inch by 6-inch engine.

One main air, vertical, single-acting, attached, 20 inches diameter by 11 inches stroke.

One main feed, vertical piston, double-acting, simplex, 10 inches by 6 inches by 12 inches.

One fire and wrecking, vertical piston, double-acting, simplex, 18 inches by 10 inches by 18 inches.

Two bilge (attached), vertical, single-acting, 3½ inches diameter by 11 inches stroke.

One hand deck, double acting, 5 inches diameter.

One general service, horizontal, double-acting, duplex, composition water end, 7½ inches by 6 inches by 10 inches.

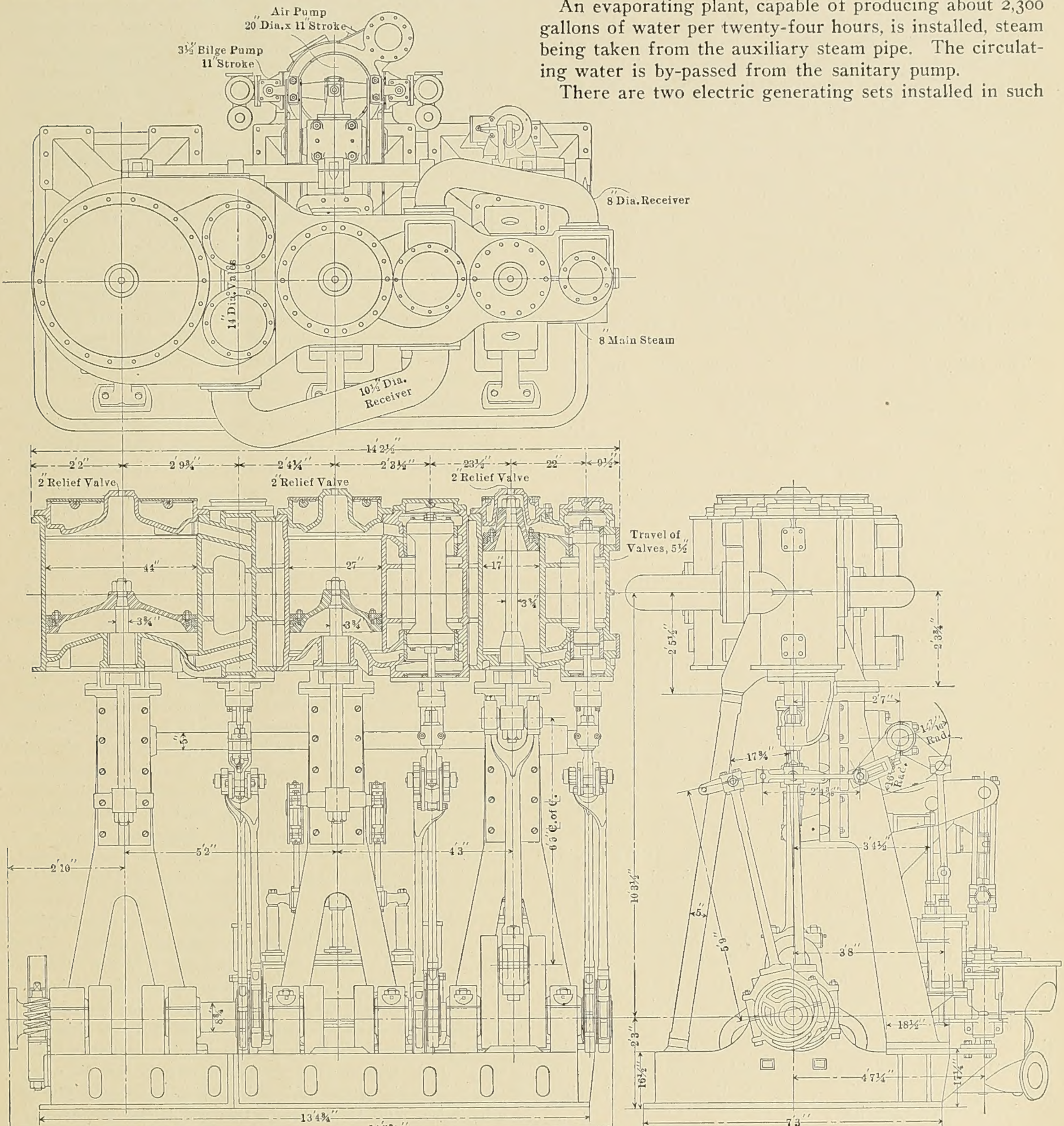


Fig. 4.—Main Engine

One fresh water, vertical, double-acting, 3½ inches by 3¼ inches by 6 inches.

Steam is supplied at 180 pounds working pressure by two watertube boilers located in a single boiler room. The general dimensions of the boilers are as follows:

Length over casing at bottom, 10 feet; width over casing, 12 feet; height to center of drum, 9 feet 10 inches; total grate surface, 123 square feet; length of tubes, 9 feet; total heating surface, about 4,400 square feet.

The steam and water drums are 42 inches inside diameter and the tubes, which are straight, 2 inches in diameter except the bottom row, which are 4 inches in diameter. The stack is 47 feet high above the grates and 4 feet 11 inches inside diameter.

An evaporating plant, capable of producing about 2,300 gallons of water per twenty-four hours, is installed, steam being taken from the auxiliary steam pipe. The circulating water is by-passed from the sanitary pump.

There are two electric generating sets installed in such a manner that either may be used to light the vessel and operate the searchlight, electric fans, shop tools and motor generator of the radio apparatus.

The main generating set is a 15-kilowatt, 125-volt direct-connected unit, driven by a reciprocating engine, while the auxiliary set is of 7½ kilowatts, 125 volts, actuated by a turbine.

Naval Architects Annual Meeting

Upbuilding of the American Merchant Marine Discussed—Safety of Life at Sea and New Developments in Ship Propulsion

The twenty-second annual meeting of the Society of Naval Architects and Marine Engineers was held at the Engineering Societies Building, New York, December 10 and 11. On account of the illness of Colonel Robert M. Thompson, President of the Society, Stevenson Taylor presided at the meeting and read the presidential address.

The annual report of the secretary-treasurer showed the membership of the Society at the close of the annual meeting in 1913 to be 812. During the year five deaths occurred and sixteen members resigned, making the membership on November 1, 1914, 791. At the opening session of the twenty-second annual meeting 38 new members were elected, and before the close of the meeting several other applicants were elected to membership. The financial condition of the society was shown to be in excellent condition, the total resources amounting to $26,440.44 (£5,425) and the total liabilities to $575 (£118), making the society's present worth on October 31, 1914, $25,865.44 (£5,307).

The following deaths were recorded during the year: James G. Winship, Thomas Dolan, Gilbert N. McMillan, George N. Gardiner, Naoji Tomikawa.

Several changes were made in the constitution and by-laws of the society relating chiefly to the election of members of the Council and the management of the society. The following were elected vice-presidents for the term expiring December 31, 1917: W. I. Babcock, Rear Admiral W. L. Capps, Prof. W. F. Durand, Rear Admiral D. W. Taylor. Members of the Council for the term expiring December 31, 1917, were elected as follows: J. E. Denton, D. H. Cox, H. L. Ferguson, Prof. C. H. Peabody, F. L. Du Bosque, Prof. H. L. Sadler, H. S. Grove and H. L. Aldrich.

Rrear Admiral W. L. Capps, former chief constructor, U. S. N., was elected a life member of the society.

An expression of the society's attitude towards the upbuilding of the American merchant marine was made in the following preamble and resolution adopted by the society in the course of the meeting:

Preamble and Resolution Adopted by the Society

"It is beyond dispute that the development of the foreign commerce of a nation such as ours is seriously hampered so long as the carriage of that commerce depends upon the convenience and ability of foreign carriers; nor can it be denied that our nation has been paying tribute to foreign nations to perpetuate such foreign supremacy, to the detriment of individual opportunity and of our established system of wages and conditions of living.

"This Society, which has for its aim the advancement of the art of shipbuilding, takes this opportunity of submitting a recommendation to the President and Congress on the recognized necessity for rehabilitating our foreign service merchant marine.

"*Resolved,* that the interests of an important industry, involving both capital and labor, can be best served by encouraging shipbuilding in American shipyards and the operation of such ships under the American flag, and that any legislation relating to our merchant marine should recognize and increase the advantage of our nation's general system of industrial development. Therefore, it is believed that such additional legislation as may be enacted should have in view the relief of existing burdens and take account of the unquestioned additional cost of operating ships in accordance with the laws and industrial policy of our country.

"To this end the society begs to offer its assistance in the consideration of technical matters or in any other way which the President and Congress may deem appropriate."

Morning and afternoon sessions were held on each day of the meeting, and on the evening of December 11 about 300 attended the annual banquet of the society held at the Waldorf-Astoria Hotel.

The following papers were read and discussed at the meeting:

International Conference on Safety of Life at Sea

BY HON. E. T. CHAMBERLAIN

Abstract

This monograph outlines briefly the organization of the London International Conference on Safety of Life at Sea and discusses briefly the general principles upon which the International Convention is based. Attention is invited to the following paragraphs:

The aim of the London Conference above all else was to demonstrate the willingness and ability of nations to agree upon standards of safety for ocean travel, then of their willingness to recognize the good faith of one another in agreeing to live up to those standards. This aim was attained in two articles, 60 and 61, and the balance of the work of the Conference related to details, important in many respects, but necessarily incomplete. The step taken is a long advance in substance and principle over the practice of the past fifty years of enforcing uniform rules for preventing collisions at sea, and it begins an era in maritime affairs.

Articles 60 and 61 seem of especial interest to the Society of Naval Architects and Marine Engineers. The establishment of international standards of safety, coupled with the obligation upon each nation to guarantee that its own ships comply fully with the requirements of such standards, offers both positive and negative advantages to the successful prosecution of their work by a body of trained men such as compose the Society. The London Convention furnishes an impetus to high grade construction work in that it secures for such work international recognition. More than mere formality is intended by Article 64 of the Convention, by which the governments of the maritime powers agree to communicate to one another "all information which they possess affecting safety of life on those of their vessels which are subject to the rules of the Convention, provided always that such information is not of a confidential nature." This article was intended to mean that the best results of the best thought of ship and engine builders shall be exchanged between nations for critical study with a view to their incorporation, if practicable, into the rules fixing international standards of construction, and to facilitate this result the Convention in Article 74 provides "the governments may through the diplomatic channel introduce into this Convention, by common consent and at any time, improvements which may be judged useful or necessary."

The Convention applies to mechanically propelled ocean vessels (steam, motor and internal-combustion engines) which carry more than twelve passengers, in foreign trade between the nations which ratify the Convention. Each nation, of course, reserves its coasting trade for its own legislation. Each nation is at liberty to exempt from the

rules of the Convention vessels which go less than two hundred miles from the nearest coast. This exemption was drawn principally to cover the trade across the channed between Great Britain and the Continent, which from Brest to the river Elbe has been described as "home trade" for many years in British laws. It would, of course, cover trade on the Baltic and on the Mediterranean if the nations with coasts on those seas deem it wise to exempt those trades. Trade on our Great Lakes is, of course, reserved from the operations of the Convention.

The American delegation at the outset favored the preparation of a convention which should also apply to freight steamers. It soon became evident, however, that to draft the different rules required for freight steamers would unduly prolong the conference, and would also so overload the conference that much less satisfactory conclusions as to passenger steamers could be reached. This difficulty was particularly serious in the matter of hull construction, where the problems connected with cargo are somewhat different from those connected with passenger steamers.

The Convention was to have been ratified not later than December 31, 1914, and was to have taken effect on July 1, 1915, but the situation, of course, has been entirely changed by the events of August. Undoubtedly it will be necessary to extend by common consent beyond December 31, 1914, the period for the exchange of ratifications, and beyond July 1, 1915, the date when the Convention shall go into effect.

Safety of Life at Sea—Application of Subdivision Rules Adopted at International Conference

BY JAMES DONALD

Abstract

After giving a brief statement of the work of the International Conference, the author designates which vessels in the United States will be affected by the convention. These vessels include existing or new passenger vessels which are or will be engaged in trades between the United States and the ports of any of the High-Contracting Parties of the International Convention, between the United States and the Philippines and between the United States and the Canal Zone. The existing vessels actually affected will be a few steamers trading between the west coast of the United States and the Philippines, a few in the transatlantic trade and the foreign steamers that may be registered under the new act approved on August 18, 1914. The Convention requirements will also be applied to all new passenger vessels which will be built for the foreign trade.

As the United States coastwise vessels do not come under this Convention, the author considers it advisable to consider such vessels with special regard to increased safety at sea. In order to show how the Convention requirements would affect a vessel in the coastwise trade, a typical passenger and freight steamer as used on the east coast of the United States is taken for investigation. It is found that this vessel, if affected by the Convention, will require two more bulkheads fitted forward unless the machinery space is placed further forward, or other arrangements made. This vessel will also require two watertight bulkheads in the after hold and to be fitted with a double bottom all fore-and-aft, whereas this vessel has only a double bottom in the engine room. If this vessel were built to conform to the Convention requirements, it will be seen from this example how some of the coastwise passenger and freight steamers would require more bulkheads in the hold and 'tween decks, the vessels would require more depth so as to allow of a double bottom being fitted, and to allow of the arrangement of the doors in watertight bulkheads, and through the vessel's side to be above the load waterline. It should be noted that in vessels where the watertight bulkheads are arranged according to the Steamboat Inspection Rules, the vessel will founder if she has any two adjoining compartments flooded.

In order to improve the conditions of safety of life in United States vessels, it is suggested that the question of increased safety in coastwise vessels should be considered by the Department of Commerce on the basis of the Convention, or even on a basis insuring greater safety than contained therein. In order to assist in the application of the Convention requirements, the following suggestions are made:

1. That statutory load line or freeboard legislation should be enacted.
2. That curves of floodable lengths should be constructed and issued by the Department of Commerce for standard types of the United States vessels.
3. That a detailed description of the "criterion of service" in Regulation Article VIII be given after this has formed the subject of further study, as suggested by the Convention.

Safety of Life from Fire at Sea

BY W. O. TEAGUE

Abstract

Widespread interest is now being taken in the United States in the movement to safeguard the traveling public from injuries and loss of life, particularly as regards transportation on land. Safety of life at sea is, however, receiving considerably more attention than in former years, except as regards the possibility of loss of life from fire, and the object of my paper is also to create interest in this important feature of the safety campaign. The greatest degree of safety can be obtained by the use of automatic sprinklers at a small additional expense, the sprinkler system to be constantly under water pressure, so that the supply will be automatic in case of fire.

I have given statistics showing that the loss of life from this source is a serious one and have briefly described several typical fires to illustrate the horror of this greatest of all the many perils of the sea.

In tracing out the history of fire prevention and protection on shipboard, it is evident that these matters have not received as much attention, nor advanced as rapidly, as on land, where statistics show practically no loss of life in factories properly constructed and protected. Similar safeguards are applicable to vessels, but general use of them has not yet begun, evidently due to the increased cost.

The principal improvements to be encouraged are the use of steel and other non-combustible materials in place of wood in the construction of vessels and the installation of automatic sprinklers, which appliance on land has proved to be the most efficient fire extinguishing agent.

I believe that these improvements can be most quickly brought about by some form of subsidy, or by educating the public to demand all practicable safeguards.

Launching Data for a Battleship

BY NAVAL CONSTRUCTOR JOHN G. TAWRESEY, U. S. N.

Abstract

The launching of a great ship is always a matter of interest to the profession, and one of anxiety to those responsible. The experience from an unbroken series of successful launches, backed by the knowledge that every

condition has been investigated and every precaution taken, is not sufficient to entirely banish the thought that there may be some unusual factor for which allowance has not been made. The data for some previous vessel, especially one of corresponding dimensions and weight, are the basis of the launching arrangements adopted for a new vessel; and the great value of such data, when full and reliable, is considered sufficient reason for adding the following notes on the launching of a battleship to the valuable papers on launching already contained in the Transactions of the Society.

The launch of the *Oklahoma* was entirely successful, and the statement of data is presented as showing regular practice, not as an example of novel methods. The arrangement for distributing the pressure at the fore poppets is effective, and is presented as an alternative to the use of crushing-chocks. Checking arrangements were not used. It may be worth noting that the retarding effect of rope stops, as generally used for checking, is greater than the work done in stretching and breaking the stops.

The moving-picture method of observation was successful and is accurate. The arrangement used is fully described in the paper, also a more convenient arrangement recommended for any future observations. Attention is invited especially to the enlarged part of a curve determined photographically, and to the closeness with which the usual stop-watch observations correspond to this curve. The proof of accuracy is the agreement of the distance between stations as determined from the microscope readings from the film, and the known distances apart at which they were located.

The distance the vessel ran beyond the calculated point before pivoting actually occurred is interesting. It is caused mainly by the effect of the wave on the distribution of displacement, and tends to somewhat increase the pressure on the fore poppets when the vessel lifts. The form of wave profile on the ship just before pivoting, also the very small movements just at the start of motion, are suggested as interesting parts of the launching operation for further investigation by the photographic method.

It is not suggested that moving-picture data are desirable for all launches; the curves show that stop-watch observations, carefully made, give reliable information. It is to be noted, however, that dimensions and launching weights change; practices, precautions and other launching conditions change; the kind and quality of materials that must be used change; and it is advisable that launchings be rigidly investigated from time to time and that accurate observations and records be made. Photographic methods offer advantages to that end.

Launching Data, U. S. S. Oklahoma

Type of vessel......................Battleship, First Line
Builders......New York Shipbuilding Co., Camden. N. J.
Date of launch..........................March 23, 1914

Principal Dimensions, Etc.

Length between perpendiculars..................575 feet
Breadth on load waterline..............95 feet 2½ inches
Mean draft ....28 feet 6 inches
Displacement ....27,500 tons
Percentage completion at time of launch.......61 percent
Weights worked into vessel..................11,765 tons
Temporary weights on board.....................85 tons
Men, tools, and dunnage.......................115 tons
Launching cradle..............................470 tons
Total launching weight......................12,435 tons
Draft after launching, forward..........13 feet 7 inches
Draft after launching, aft..............16 feet 4 inches

Building Slip, Launching Ways, Cradle, Etc.

Declivity of building slip, per foot............11/16 inch
Declivity of keel blocks, per foot..............11/16 inch
Length of ground ways over all..................644 feet
Length of ground ways submerged.................167 feet
Width of ground ways (each).....................60 inches
Thickness of ground ways........................16 inches
Declivity of ground ways, per foot.............11/16 inch
Camber of ground ways...........................None
Inclination of ground ways, transverse, per foot...⅜ inch
Spread of ground ways, center to center..28 feet 6 inches
Material of ground ways.....Yellow pine faced with oak
Length of sliding ways over all.................473 feet
Length of sliding ways, effective...............465 feet
Thickness of sliding ways.......................15 inches
Maximum width of sliding ways..................58½ inches
Effective width of sliding ways.................57 inches
Bearing area ....4,420 square feet
Material of sliding ways......Yellow pine faced with oak
Length over which poppets distribute pivoting pressure, 23 feet
Area under poppets to take pivoting pressure, 220 square feet
Projected length of curved bearing surface under fore poppets ....21 feet 9 inches
Projected area of trunnion segment to take pivoting pressure ....208 square feet
Number of wedges, spaced 17-inch centers...........590
Wedges, oak, 9 feet by 6½ inches, tapered ½ inch per foot.
After end of sliding ways at start, up from water's edge ....6 feet
After edge of rudder at start, up from intersection of prolonged keel line and water, about..........9 feet
After perpendicular to after poppet bearing on ways, 66 feet
After perpendicular to after poppet bearing on ship, 78 feet
Forward perpendicular to forward end of sliding ways, 44 feet
Forward perpendicular to center of fore poppets..59 feet
Means for distributing pressure at fore poppets, Rocker formed as a segment of a trunnion

Pressure, Velocity, Coefficients, Etc.

Total weight on ground ways................12,435 tons
Initial pressure per square foot.................2.82 tons
Maximum pressure per square foot over ground way ends, ...5.3 tons
Center of gravity forward of center between perpendiculars ....7.9 feet
Distance traveled to calculated pivoting.........459 feet
Distance traveled to observed pivoting..........569 feet
Distance traveled from calculated pivoting to end of ways ....181 feet
Calculated buoyancy at pivoting................8,875 tons
Pressure on fore poppets at pivoting (neglecting buoyancy of packing) ....3,090 tons
Pressure per square foot under fore poppets at pivoting ....14.05 tons
Pressure per square foot on projected area of trunnion segment at pivoting ....14.85 tons
Distance traveled to bring center of gravity over end of ways......................................410 feet
Depth of water over ends of ways (actual corresponding to 5 feet 10 inches tide)..........9 feet 6 inches
Least excess of calculated moment to prevent tipping, 52,200 ton-feet

Static drop of vessel where poppets leave the end of ground ways ....6 feet 4½ inches
Average velocity first 100 feet (5.8 feet per second), 3.3 knots
Maximum velocity (23.6 feet per second). Nearly 15 knots
Ship hung 2 or 3 seconds and then started slowly without application of rams or other means.
Travel before rudder entered water, about........25 feet
Travel to point of maximum velocity, about......100 feet
Time to point of maximum velocity........17.25 seconds
Travel to point of drop, fore poppet at end of ways, about ....640 feet
Time to point of drop, about................41.6 seconds
Coefficient of starting (sticking) friction, about....0.0575
Coefficient of friction, average first 50 feet, about...0.026
Coefficient of friction and resistance, average first 100 feet, about 0.016
Coefficient of friction and resistance, minimum, about 0.004
Coefficient of friction and resistance, average after 250 feet run, about...........................0.06

MISCELLANEOUS

The recorded weights at time of launch were subsequently confirmed by the observed displacement.

Method of release—hydraulic triggers.

Pressure used for triggers—Started with 250 pounds per square inch and was gradually increased as blocks were removed to a maximum of 1,600 pounds per square inch just before dog shores were dropped.

Temperature on day of launch on building slip, 31 degrees F.

Lubricant on ground ways—Under fore poppets applied several weeks before launching. First a thin coat of stearine, next a 9/16-inch thick coat half tallow, half stearine.

On remainder of ground ways under sliding ways, applied two to three weeks before launching. First a thin coat of stearine, next a mixture of three parts tallow to one part stearine.

Remainder of ground ways to a point 36 feet beyond low water mark, applied by means of cofferdams three to four days before the launch, and touched up the day before on account of damage from ice—Tallow mixed with lard oil.

Lubricant on sliding ways, applied two to three weeks before launching—Forward 80 feet thin coat of stearine, whole length with launching grease smeared on lightly.

Lubricant on pivoting surface under fore poppets—A mixture of half stearine and half tallow applied 9/16-inch thick.

Removing blocks, etc.—Some of the blocks at ends of vessel and most of the shores were removed the day before the launch.

Wedges were set by mauls and alternate keel blocks removed, starting at 7.30 A. M. on day of launch. Rallies on the wedges, using rams, were made at 10.00, 10.11, 10.22 and 10.32 A. M., the last block was out at 12.10 P. M., dog shores dropped at 12.13 and ship released at 12.15 P. M.

About 280 men were employed below the ship; some 40 of these afterward went on board, making about 120 men on the ship at time of launch.

Vessel was launched just as tide was turning ebb; there was a moderate breeze from the southwest.

Stability of Vessels as Affected by Damage Due to Collision

BY WILLIAM GATEWOOD

ABSTRACT

In this paper, the conditions of stability of a coastwise passenger and freight steamship are investigated. The vessel is considered as subdivided in accordance with the rules set forth by the International Convention of 1913-14 as a vessel engaged in a mixed cargo and passenger service, and as damaged by collision opening one compartment to the sea. It is shown that the stability is threattened almost at once, and that, to prevent capsizing, an initial metacentric height of not less than 18 inches is necessary for a vessel of the size considered. Attention is invited to the danger caused by the small freeboard of the tops of the bulkheads, in case of rough weather at time of collision or shortly thereafter.

The Expansion or Contraction of Dimensions and the Effect Upon Resistance

BY PROFESSOR HERBERT C. SADLER

In the preparation of the plans for a new vessel it frequently happens that the designer has at hand the trial data as to speed and power for a vessel, similar, so far as the coefficients of form are concerned, but whose ratios of dimensions are not the same as those of the proposed vessel. From former experience and results of model tests already published, it may be possible to estimate the effect of change in ratios of dimensions with a fair degree of accuracy, but in order to obtain additional data upon this subject and to bring the results into a more concrete form the following investigations were undertaken:

Three different types of ordinary mercantile forms were designed ranging in longitudinal coefficients at the deepest draft from .551 to .674. Each model was tested at three different drafts, but the same actual drafts were used in each case.

A number of models of each type were made of varying breadths, by simply expanding or contracting the parent form in this direction only, the length and draft in each case remaining constant.

In a similar manner the length and breadth were held constant and the under-water form changed by varying the distance between the original waterlines only—i. e., expanding or contracting the draft. Also, the breadth and draft were kept constant and a series of models made by expanding or contracting the distance between the transverse stations—i. e., expanding or contracting the length.

Finally, the three forms were tried of the same displacement, breadth and draft, but of different lengths and hence different coefficients of form.

The coefficient of midship section was kept constant throughout the series.

In all of the foregoing, therefore, the displacement for each type was allowed to vary in the same ratio as the variation of the particular dimension.

The particulars of the three types are given in the following table:

DRAFT.	TYPE 1.			TYPE 2.			TYPE 3.		
	C_m	C_l	C_b	C_m	C_l	C_b	C_m	C_l	C_b
a.........	.936	.674	.63	.936	.606	.567	.936	.551	.515
b.........	.92	.665	.612	.92	.598	.537	.92	.544	.501
c.........	.904	.648	.585	.904	.583	.526	.904	.530	.479

The varying ratios of length and breadth and draft are shown on the respective curves.

The curves of sectional areas of the parent forms are shown in Fig. 1, and represent the three different types of varying length and constant displacement. In presenting the results of the experiments it has been deemed advisable to give them in the form of wave-making resistance per ton of displacement, in terms of speed-length ratio. For any particular case the surface friction is readily calculated, and although when total resistance is con-

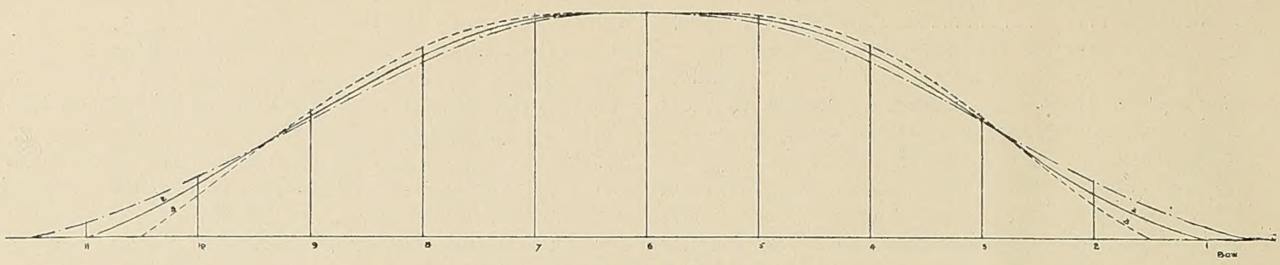


Fig. 1.—Curves of Sectional Areas

sidered the results may appear different from those due to wave resistance only, it is the latter which is usually the unknown quantity. The fact that the residuary resistance is obtained by subtracting the frictional from the total resistance, together with possible minor experimental errors, would probably account for certain inconsistencies which appeared in the final results. In general, however, within the limits of economical speed for each type, or before the region of the first "hump" in the resistance curve, the results were fairly consistent, and the following curves represent the average variation in each case. Beyond the above speeds the variation in resistance did not seem to follow any simple law but varied somewhat with the speed.

The curves shown in Fig. 2 represent in general the variation of residuary resistance per ton of displacement with respect to breadth. They are the results for the medium draft (b) for each type, but the same characteristics were found to hold for the other drafts at which the models were tried.

Within the limits of the variation of breadth shown, the residuary resistance appears to vary as about the 1.65 to the 1.7 power of the breadth, or the residuary resistance per ton of displacement as about the .65 to .70 power of the breadth, if the lines are simply expanded or contracted and the displacement allowed to vary accordingly.

The effect of variation of draft due to expanding or contracting the dimension in this direction, did not appear

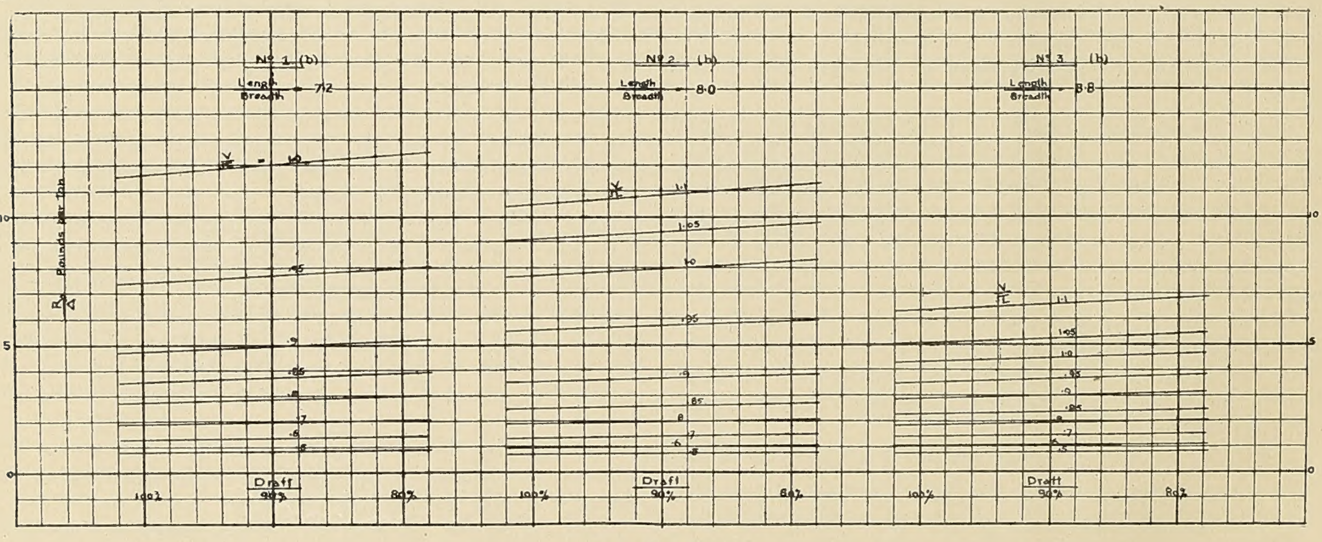


Fig. 2

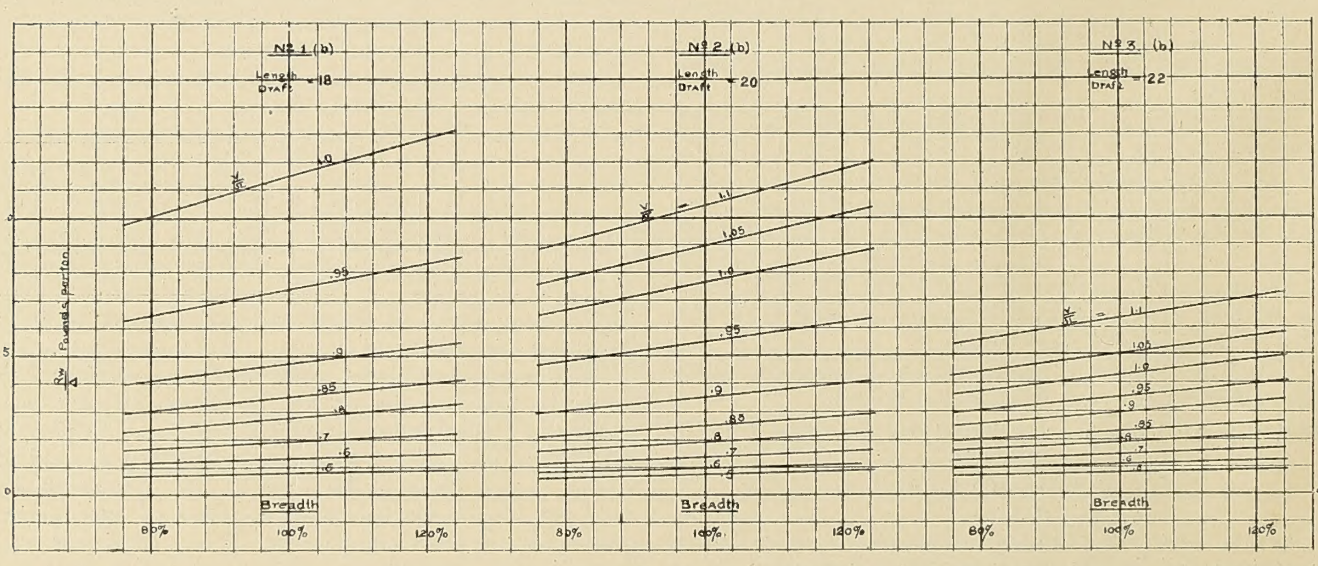


Fig. 3

to be quite as consistent as in the previous case, but in general the average results are shown in Fig. 3. They are for the forms represented by the medium draft (b). Up to the limit of economical speed the residuary resistance varies as about the .65 to .7 power of the draft. Above these speeds the index gradually increases. The residuary resistance per ton of displacement therefore varies inversely as about the .35 to the .3 power of the draft.

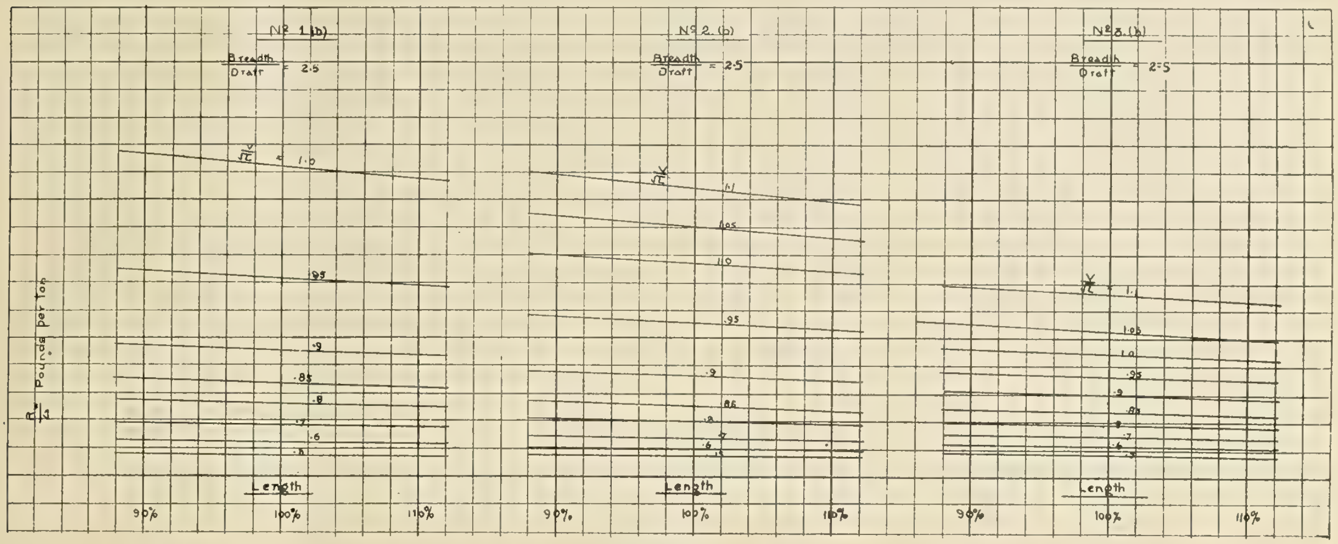


Fig. 4

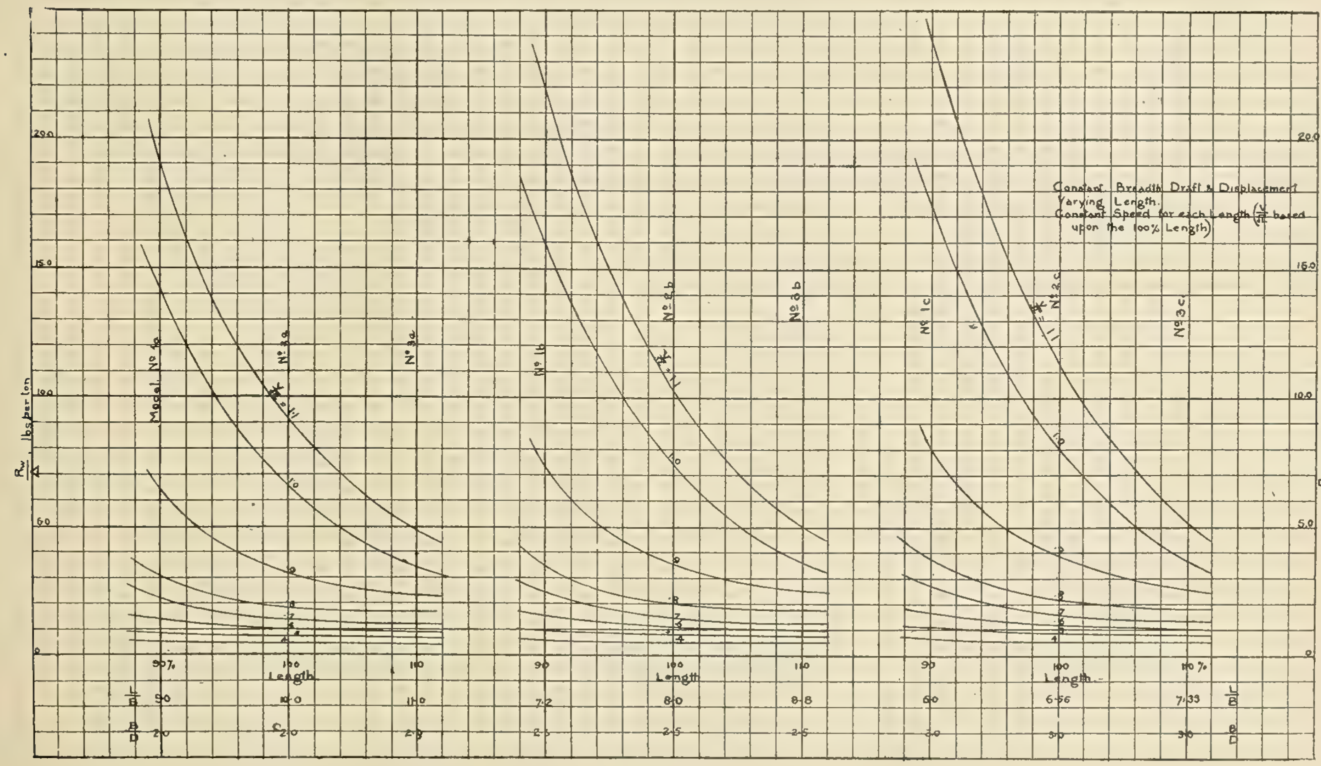


Fig. 5

Effect of Varying Length Only

If length alone is varied, breadth and draft being kept constant, we have simply a combination of the foregoing; for if all dimensions were varied proportionately the residuary resistance per ton of displacement would be constant at constant speed-length ratios. Increasing, say, the length only is therefore equivalent to reducing both breadth and draft of the parent form simultaneously.

As a check upon this, each of the forms was expanded or contracted longitudinally, and the results are shown for the medium draft (b) in Fig. 4. If the length be increased, say, n times, breadth and draft remaining constant, we obtain a similar form to that of the parent type in which the breadth and draft have each been reduced n times; and therefore if the residuary resistance per ton of displacement at corresponding speeds varies as the .7 power of the beam and inversely as the .3 power of the draft, the combined result would be that this factor will vary as $n^{.3} \div n^{.7}$ or $\frac{1}{n^{.4}}$. In other words, the residuary resistance per ton at constant speed-length ratio will vary approximately inversely as the $(\text{length})^{.4}$. An examination of the above curves, Fig. 4, will show that this is practically the case.

As the three original parent forms were made of the same displacement but of different lengths, the effect of influence of length for this particular series could be readily obtained. The curves, Fig. 5, show the results for the three different drafts at which the models were tried. They represent constant speed curves for varying lengths with constant beam, draft and displacement, and illustrate the well-known influence of length as affecting residuary resistance. The total resistance curves would not, of course, show such a marked difference, as the longer form, though finer, would have a greater friction than the shorter and fuller form.

Shallow-Draft Types

In connection with some experiments upon certain types of river steamers, such as those of the Mississippi stern-wheel type, occasion was had to determine the effect of variation of breadth only. These are rather extreme types where the ratio of length to draft was from 40 to 50 and the ratio of breadth to draft varied from about 8 to 12. Two different types were tried, the stern in both cases being that usually adopted for the stern-wheel vessel, and the bows either ship-shape or "scow" form.

In these cases the wave-making resistance at corresponding speeds, within the limits of speed at which these vessels would normally be run, appears to vary as about the .75 power of the beam, or per ton of displacement inversely as the .25 power of the beam.

As the models of the above contained a large percentage of parallel middle body, this part, which represents a practically rectangular form, was also tried at different breadths. The ratio of breadth to draft was the same as for the previous forms, but in this case the residuary resistance appeared to vary directly as the beam, or the residuary resistance per ton of displacement was constant at corresponding speeds.

In conclusion, a word of caution should be given about extending the above results beyond the limits of the experiments, both with regard to dimensions and speed. Within these limits of, say, 20 percent variation no serious error will be involved if the residuary resistance per ton of displacement at constant speed-length ratios be assumed to vary as about the .7 power of the breadth, inversely as the .3 power of the draft, and inversely as the .4 power of the length; or the residuary resistance be assumed to vary as the 1.7 power of the breadth and as the .7 power of the draft, and .6 power of the length, for similar normal mercantile types at corresponding speeds.

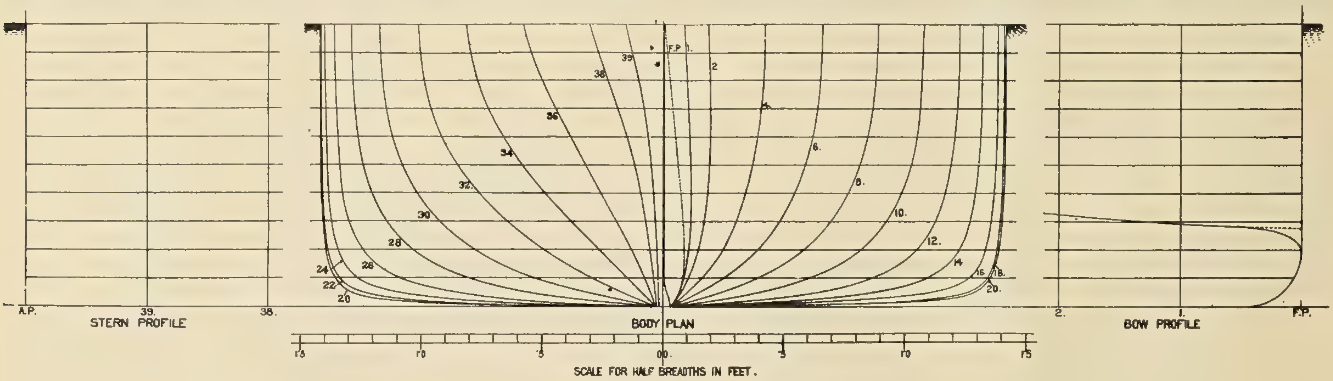
The results also emphasize the fact that the draft is the more economical dimension to increase, if increased displacement of a given type is desired.

For very wide and shallow forms, however, the influence of breadth upon residuary resistance does not appear to be as marked as in the case of the more normal forms.

Some Experiments with Models Having Radical Variations of After Sections

BY NAVAL CONSTRUCTOR D. W. TAYLOR, U. S. N.

When we determine the form of a ship there are two things which must be done in connection with every station or section. We must, by some means, fix the area and then determine the form or shape to be given the section having the given area. Taking ships as they are, for given dimensions and displacement there is not room for very large optional variations of sectional area except near the extremities. The designer has a fairly free hand, however, when it comes to the shapes of the sections, particularly toward the extremities.



Stern A. Body Plan, Bow and Stern Profiles

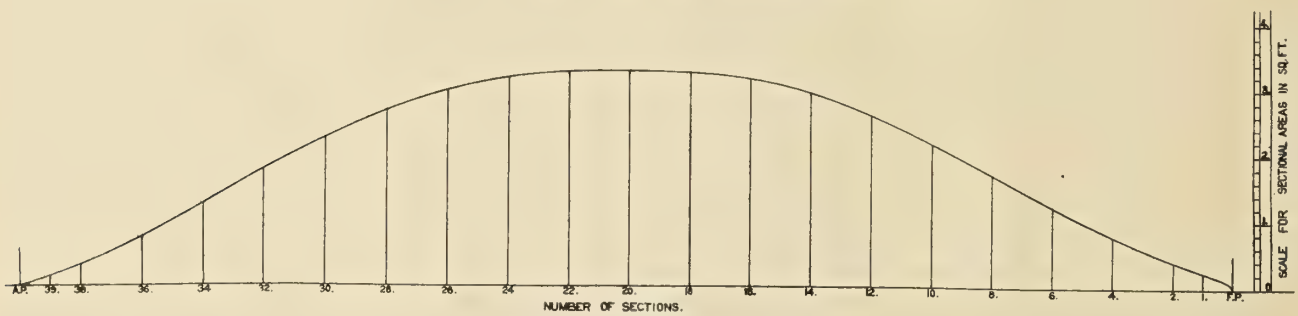


Fig. 1.—Curve of Sectional Areas

There are, of course, matters to be considered in connection with these shapes other than the question of resistance, such as seaworthiness, carrying capacity, etc., but it should be understood that in this paper questions of resistance only are taken up. Broadly speaking, as regards the shape of sections, the accepted practice is to approach the U-type forward and the V-type aft. From our experience at the U. S. Model Basin this practice, as regards resistance, would appear fully justified as to the bow, the U-type of section being nearly always desirable

forward. Moreover, the resistance seems to be more affected by changes forward than by the changes aft, or, to put it in another way, to depend more upon the forward than upon the after form.

Systematic variations of form of entrance generally result in systematically varying resistance and allow definite conclusions to be drawn. When it comes to the run, however, we find it much harder to draw definite conclusions. Changes in the form of the after sections appear to affect the resistance less than do changes forward, and changes of resistance for systematic changes of after form are not always systematic. So, while we feel that the standard practice is probably right and that V-sections aft are desirable from the point of view of resistance, we do not feel that here we are upon such firm ground as with regard to the U-sections forward.

In view of the difficulty of obtaining definite characteristic results from comparatively small changes of shape aft, we have recently made some experiments with after forms of radically differing shapes, and it is the object of this paper to put before the Society the results obtained.

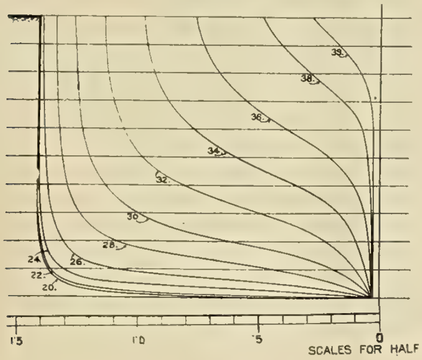


Fig. 2.—Stern B

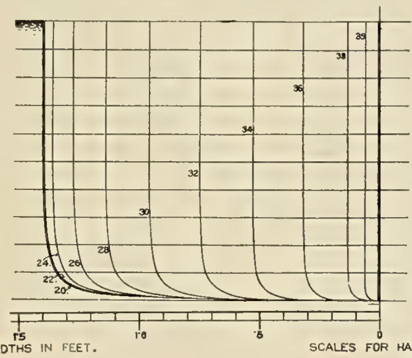


Fig. 3.—Stern C

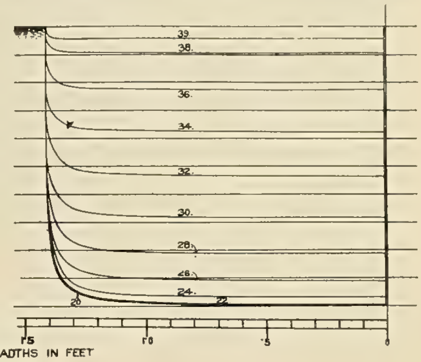


Fig. 4.—Stern D

would start the water up more quickly than in the standard type. The idea of stern C was to carry right aft sections derived from the midship ssection (98 percent coefficient) beam only being decreased; in other words, to make a wall-sided model. Stern D was stern C disposed horizontally instead of vertically. The beam was kept constant and draft only was changed, as we went aft, the sections having 98 percent coefficient. In other words, stern D was an exaggeration of the flat-stern type.

Stern E was a combination of sterns C and D, the attempt being made to combine them half and half, as it were, and coax the water up along a bilge diagonal. In stern F not only was the coefficient .98 retained for all sections, but they were made geometrically similar to the midship section, beam and draft both being decreased as necessary to obtain the required area. For sterns C, D and F the sectional coefficient is constant—.98, as already stated.

Fig. 9 shows how this constant sectional coefficient contrasts with the curves of sectional coefficient of A, B and E. It is typical of V-sections that the sectional coefficients are below .5, but when we consider that in the conventional type the after sections include actual or virtual dead wood, it is evident that the numerical value of a sectional coefficient aft has small significance as indicating the nature of the form with which the water has to deal.

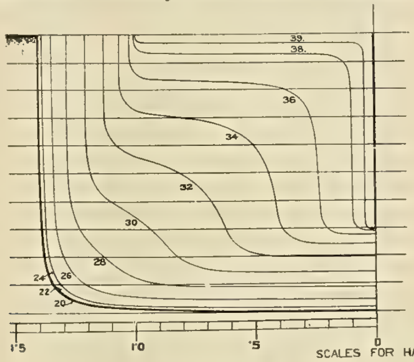


Fig. 5.—Stern E

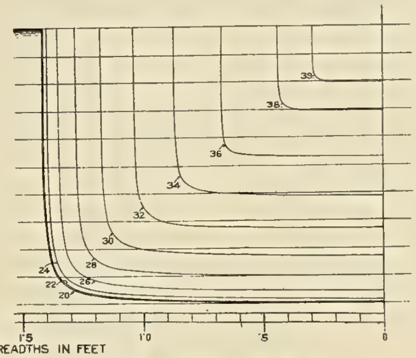


Fig. 6.—Stern F

Six after bodies were tested for resistance, all with the same fore body and all having the same curve of sectional areas. All models were 20 feet long in accordance with the standard practice at the U. S. Model Basin. The beam was 1,828 feet; draft, 1,179 feet; displacement, 2,500 pounds in fresh water; midship section coefficient, .98; longitudinal coefficient, .6122; block coefficient, .60.

Fig. 1 shows the original lines, including stern A and the curve of the sectional areas for all models. This was one of the models tested last year, the results being included in my paper of last year on "Relative Resistance of Some Models with Block Coefficient Constant and other Coefficients Varied." Sterns B, C, D, E and F are shown in Figs. 2, 3, 4, 5 and 6. Fig. 7 shows the curves of total resistance and the estimated wetted surface resistances, and Fig. 8 shows the residuary resistances.

The underlying idea of stern B was a shape which

The outstanding result of the experiments was the good showing of stern F. Of course this was partly due to small wetted surface, but stern F shows up very well in the curves of residuary resistance, indicating that even with a conventional dead wood added it would still be somewhat the best.

Stern D, the exaggerated flat stern, undoubtedly makes the worst showing in Figs. 7 and 8, which is at first sight surprising in view of the fact that the wide, flat stern is used with success on many fast boats. But the wide, flat stern as used is usually of a type somewhere between D and F, and Figs. 7 and 8 do not go up to torpedo-boat speed. For 20-foot models torpedo-craft speeds correspond to 8

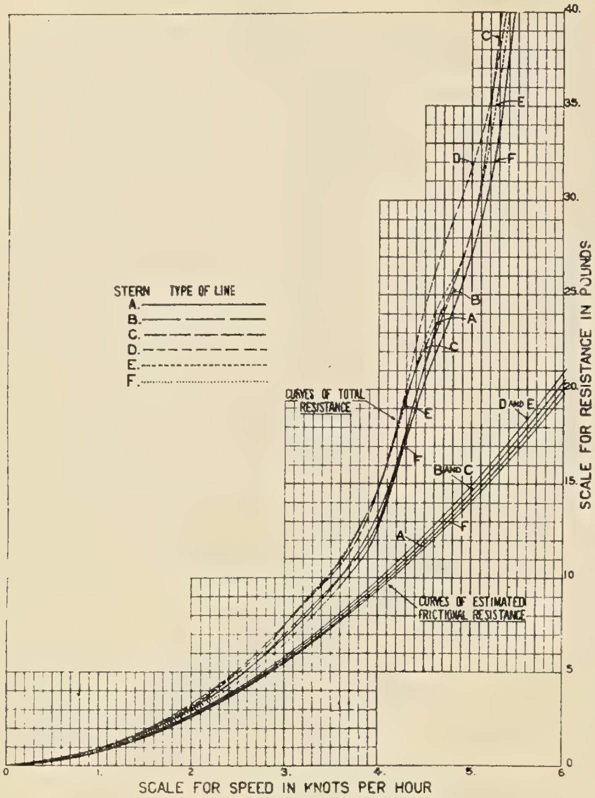


Fig. 7.—Curves of Total Resistance

knots or more, and it is quite possible that at 8 knots stern D would show the least resistance. The models used were not of high-speed type, having four or five times as much displacement for a given length as a high-speed torpero-boat model, and hence were not tested to high speeds. It is interesting to note that the excessive resistance of stern D at speeds a little below five knots is really due to a characteristic favorable to high speed. The virtual or effective length of model D is greater than that of the others and, when the curves of the others are past the 4½-knot hump and drop down into the succeeding hollow curve, D is still on the hump.

Other conclusions might be drawn from the curves, but

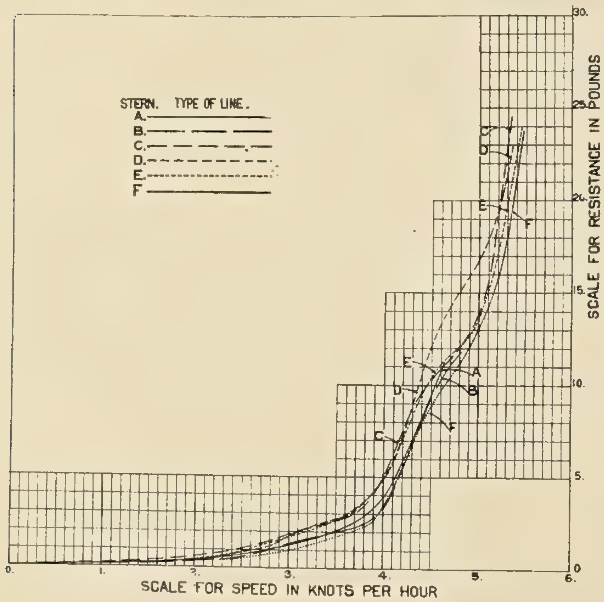


Fig. 8.—Curves of Residuary Resistance

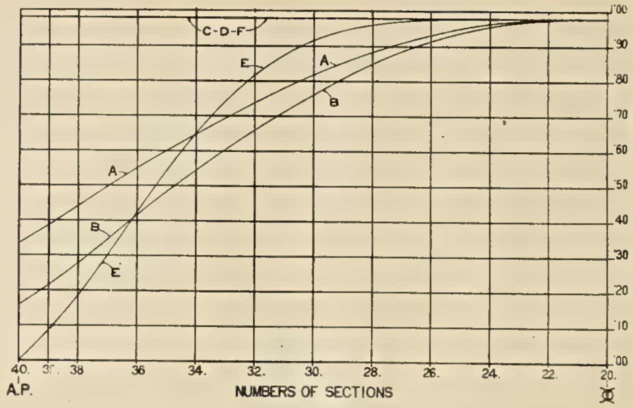


Fig. 9.—Curves of Sectional Coefficients

it would not be safe to generalize from a few results. Bearing in mind that a ship of the displacement length coefficient involved would not be powered in practice for speeds above 4 knots, the results appear to indicate that gain could be made at practical speeds by departing from the conventional type of after body, but that they would be comparatively small, after all. They would be of the 5 percent order, not 15 or 20 percent.

Recent Development in Submarine Signaling

BY J. B. MILLET

Abstract

The system of sending warning signals under water from shore to ship or from ship to ship has now been accepted and put in operation throughout the world. There are in all nearly 200 signal stations in operation to-day which may be used by ships approaching in fog or thick weather. Nearly all the large shipping companies in the world have one or more ships installed with a receiving apparatus which enables them to locate their position by listening and ascertaining the direction through the submarine bells, which are operated as a part of the lighthouse service of the various countries. Over 1,200 vessels are equipped with a receiving apparatus and a proper notation is now placed against all vessels so equipped in Lloyd's "Register of British and Foreign Shipping," "Record of American and Foreign Shipping," "Bureau Veritas" and the "Germanischer Lloyd."

Within a short time an apparatus has been invented by Prof. Reginald Fessenden, called the "oscillator," which consists briefly of a heavy diaphragm operated under water by means of electric current, and which can be used for sending signals by the Morse alphabet. This apparatus has been used successfully in detecting the presence of icebergs by sending sound through the water and then ascertaining the direction from which the echo comes. Signals sent by this oscillator have been distinctly heard at a distance of 30 miles. Battleships, transatlantic steamers, and all other large vessels, if equipped with the oscillator, are therefore afforded a means of intercommunication. Since the oscillator is not only a transmitter of sound but a good receiver of sound, it serves a double use. If submarine boats are equipped with the oscillator, they should be enabled, without much difficulty, to detect the presence of any vessels which they wish to strike, by listening to the sounds which are inevitable on any large steamer. It would therefore follow that a submarine boat could detect the presence of its mark when several miles off, and without using its periscope it could make its attack. It could also communicate with its headquarters and receive and give any messages that are desired. It is,

therefore, seen that this invention should add greatly to the efficiency of a submarine boat, as it has already added greatly to the safety of ships at sea.

The Thermodynamics of the Marine Engine

BY JOHN F. WENTWORTH

Abstract

It is the contention of the writer that there is no real Diesel type engine in use to-day. The contention is that the present engines owe their value and efficiency to the same principles which govern the gas or so-called explosion engines. Any gain in efficiency in the present oil engines due to the use of high-pressure of compression is more than offset by disadvantages resulting from this same high-pressure of compression. If this be not so why are not gas engines run on the so-called Diesel principle? It is possible to inject a blast of gas into the cylinder at the end of compression obtaining the same results now obtained in the engine built under the so-called Diesel principle.

A diagram is given, showing how the temperature rises very rapidly during the period of injection and in a manner contrary to the Diesel theory. It is owing to this divergence from the Diesel theory that the Diesel engine is a commercial success. Indicator cards and also temperature curves for various engines are also given. These data accentuate the contention that the Diesel engine is nothing but an explosion engine modified, as it must be, to use as a non-volatile oil.

Attention is called to the fact that injection air need not be cooled and should not be cooled, at least to the present extent. The energy of a pound of air at room pressure and temperature is the same as the energy of the same weight of air after it has been compressed to 1,000 pounds pressure and cooled to room temperature. If the energy depends upon the temperature and not upon the pressure, then it behooves us to refrain from unnecessary cooling of the injection air.

A set of curves is given for determining the pressure of compression needed to assure ignition with the temperature at the beginning of compression known. If the exponential curve based on 1.405 for an exponent is correct for the adiabatic compression of atmospheric air, then this set of curves will give the nearest result. If a different exponent be used the result will be correct at one point and one point only. The error in the curve based on 1.405 lies in the effect of radiation. In a warm cylinder air takes up heat at the beginning of compression and gives heat up at the end of compression. By using an exponent of 1.35 or 1.30 curves will be obtained which will cross the real curve (if there be sufficient radiation loss). This point of intersection will be the only correct spot on the artificial curves, and there is no means for knowing where this point will be.

Cards taken from the writer's experimental engine are also given. When taken these cards were considered as failures for the most part. A collection of these cards, however, tends to prove that which the writer has contended for years, namely, that the so-called explosion engine is limited in its efficiency by the fact that its pressure of compression is restricted to a maximum level. The Diesel engine is limited in its pressure of compression to a minimum level. Perhaps the ideal condition lies somewhere between the two conditions. A method of governing is proposed by the writer by means of which the friction loss in the main bearing should be reduced very materially.

In an ideal thermodynamic system suggested by the writer there is no loss of heat units in the plant from the time of combustion in the cylinder till the exhaust gases leave the economizing boiler and the spent steam is condensed in the condensers except the accidental radiation. This modification in the oil engine not alone gives a greater efficiency, but makes a far more perfect engine. By means of the hot jacket the engine can run at a much slower speed, and also extreme pressures can be avoided giving an increase in efficiency and enabling the weight of the engine to be reduced.

Refueling Warships at Sea

BY SPENCER MILLER

Abstract

Mr. Miller's paper indicates the value of mastering the art of refueling warships on the high seas. The British blockade in the North Sea has proved that blockades are not obsolete. Of the hundred coal-burning cruisers said to be patroling the North Sea, probably fifteen are frequently, if not continuously, absent from patrol service, filling their coal bunkers in English harbors or English roadsteads. Every cruiser retired from the patroling line to replenish its coal bunkers materially weakens the patroling fleet, for the absent ship is temporarily useless for fighting purposes. While in the blockade of Charleston, during our Civil War, not more than 75 percent of the blockading ships were continuously on duty, Mr. Miller admits, for purpose of illustration, that the efficiency of the British patrol may be as high as 85 percent. Fifteen British cruisers continuously absent from patrol duty represents a loss of $30,000,000 (£6,160,000) worth of ships from service. Such a blockade can be maintained at nearly 100 percent efficiency when able to replenish their bunkers at sea.

The triumph of the submarine has modified blockading methods. To be safe from submarine attack cruisers must steam ahead at not less than 10 knots. Any attempt to coal broadside while steaming at 10 knots would be attended with great difficulties, unless the sea be smooth. Even if coaling broadside under a 10-knot headway at sea be permissible while steaming head on into the sea, it would be attended with great danger if a zigzag course was taken, which would throw both ships at times into the trough of the sea.

None appreciates the value of refueling warships at sea more than the British Admiralty. Their experiments to find or develop suitable coaling at sea apparatus have covered a period of years and the expenditure of hundreds of thousands of dollars. The British Admiralty own but one collier. Colliers carrying coal for British warships are privately owned and chartered as required. The British Admiralty have mastered the art of oil bunkering under headway in smooth seas. Great Britain's fastest cruisers, protecting English ships on the Atlantic Ocean, doubtless are absent from the lanes of travel from 15 to 25 percent of their time, coaling at Halifax or Bermuda.

The German Admiralty have devoted several years developing and testing out at least two cableway systems for coaling cruisers on the high seas. The Adam system adopted by Germany has been most successful. The German Admiralty required an apparatus to be carried wholly by the cruiser and capable of taking coal from captured merchantmen on the high seas at the rate of 50 tons per hour. The German cruiser *Roon* was known to have been equipped. The manufacturers of the Adam system were

commanded not to disclose the names of the cruisers equipped with the apparatus, nor even the number of such apparatus installed upon cruisers.

The European war has shown how easy commerce destroyers can replenish their coal supply from captured ships and how thoroughly the German cruisers have been supplied with coal in various quarters of the globe. Many incidents connected with the war indicate that the high seas is an extremely safe place for vessels to hide, especially if they use their wireless to listen but never to talk.

The Japanese battleship *Hizen* is reported to have arrived at Honolulu fully coaled and provisioned, 14 days from Japan. The *Hizen* was formerly the Russian battleship *Retvizan*, built by the Cramps and equipped with a marine cableway, described in a paper read before this Society in 1904.

In 1903 few of our ships coaled faster than 30 tons per hour alongside in harbors. This spring the U. S. S. *Wyoming* took on 2,100 tons of coal in five hours from two colliers in Guantanamo Bay. The collied *Jason*, equipped with marine transfers, described before this Society in 1910, delivered a maximum of 465 tons in one hour, and delivered 1,040 tons in three working hours. The U. S. Navy leads in large colliers and improved appliances for coaling broadside in smooth waters, as well as in marine cableways coaling warships in tow under headway on the high seas.

The marine cableway on the U. S. collier *Cyclops* is the outcome of study and experiments covering a period of twenty-one years. It is operated by three automatic tension engines, a new marine implement. The automatic tension engine contains a noval form of tension governor whereby the slightest change in the tension of the suspended cable produces a corresponding and proportionate change in the steam pressure. A slackening of the suspended cable produces an instant raise in the steam pressure sufficient to restore the tension to normal. A tightening of the suspended cable produces an instant reduction of the steam pressure, permitting the cable to pay out until the tension is restored to normal. The governor is extremely sensitive to the tension in the supporting lines, maintaining them practically uniform at all times. Loads up to 4,000 pounds are picked up from the deck of the collier, transported about 500 feet and dropped on the deck of the warship at intervals averaging one minute and six seconds; frequently at intervals of 50 seconds.

The marine cableway on the collier *Cyclops* has met the most exacting requirements of the Navy Department, there being no demand for any improvements or changes in the apparatus. It has been tested in heavy seas with the huge collier *Cyclops* rolling 20 degrees. On another occasion coaling was carried on between the collier *Vestal* and the battleship *Virginia* in a dense fog in which neither ship could see any part of the other.

An earlier form of marine cableway, tested by Great Britain, was successful in coaling the battleship *Trafalgar* in half a gale of wind. In Italy the third-class cruiser *Liguria*, 2,280 tons, received 60 tons of coal per hour in a sea so rough that the screws of the cruiser were frequently seen from the collier *Sterope* in tow.

Fighting ships of the U. S. Navy, omitting destroyers and submarines, comprise 67 coal-burning ships and 3 oil-burning ships. In future, whether these ships serve for blockading purposes, or whether steaming at a distance for a foreign coast, they could remain continuously with the fleet, coaling broadside when the sea was smooth and with the marine cableway in anything short of a very rough sea, while steaming at the speed of the fleet or the patrol.

Our First Frigates—Some Unpublished Facts About Their Construction

BY HON. FRANKLIN D. ROOSEVELT
Assistant Secretary of the Navy

ABSTRACT

The present navy of the United States had its origin in the act of Congress of 1794, which authorized the building of six frigates, four of which were to carry 44 guns and two to carry 36 guns each. The appropriation made available was $688,888.82. The principal dimensions of the frigates are as follows:

44-*Gun Frigates.*—Length of gun deck from rabbit of stem to post, 174 feet 10½ inches; length of keel, 145 feet; molded breadth of beam in the extreme part, 43 feet 6 inches; height of wing transom above rabbit of the keel, 25 feet 8½ inches; height of lower deck transom above rabbit of keel, 20 feet 9 inches; height between gun deck and lower deck, 6 feet 4 inches.

36-*Gun Frigates.*—Length of gun deck from rabbit of stem to post, 163 feet 7 inches; length of keel, 136 feet; molded breadth of beam in extreme part, 40 feet; height of wing transom above rabbit of keel, 24 feet; height of lower deck transom above rabbit of keel, 19 feet 2 inches; height between gun deck and lower deck, 6 feet.

Various features connected with the building of these ships, including the difficulties encountered and the added appropriations needed for their completion, are given in this paper taken from early records of the Navy Department which were hitherto unpublished. Special reference is made to the frigates *United States, Constitution* and *Constellation.* Their records throughout the years have been a monument to the men who planned them, the men who built them, and the men who manned them. All of them became victors in battle—the *Constellation* in actions against the French frigates *Vengeance* and *Insurgente;* the *United States* in the victory over the British *Macedonian,* and the *Constitution* in the capture of the British *Guerriere, Java, Cyane* and *Levant.* Two of the three, the *Constitution* and the *Constellation,* are proudly carried on the rolls of the United States Navy to-day, 117 years after their launching.

The Behavior of Riveted Joints Under Stresses

BY JAMES E. HOWARD

ABSTRACT

Unit values of the component parts on which the computations of strength of riveted joints are based are not held to be fixed values as commonly assumed. A reinforcement in strength of the net section occurs, a variable factor which reaches its maximum in close pitched work, diminishing as the pitch increased, and eventually having a negative value in wide pitched multiple riveted joints. Over a certain range of pitches the ratio of net to gross section of plate may be practically compensated for by this reinforcement, thus resulting in joints of different pitches having substantially identical efficiencies.

The ultimate strength of a joint, however, is not regarded as an index of endurance to repeated stresses; that the elastic behavior of the joint must be considered in such cases. That a good distribution of stresses in riveted construction is not always attained. While certain joints of considerable strength, and high efficiencies, possess a degree of rigidity comparable to that of the solid plate at low stresses, nevertheless, under loads ranging from 15,000 to 25,000 pounds per square inch the extension of the joints is greatly increased over that of the solid plate.

That frictional resistance contributes its share in the rigidity of joints. In order to secure maximum frictional effects from the contraction of the rivets in cooling, the plates should be firmly held together until the rivet has nearly cooled, a requirement obviously militating against rapid driving, but necessary for the best work. Cover plates and splice plates do not immediately take up the full stresses. A progressive gain or transfer of load goes on for several rows of rivets. Chain riveting gives a favorable impression from the behavior of such joints while under test. Staggered riveting not infrequently fails by a zigzag line of fracture, the rivets in adjacent rows in some cases being so located as to favor this method of fracture. The rigidity of joints in actual construction is not held to be greater, but probably less than that witnessed in laboratory tests.

Riveted joints tested at higher temperatures showed strength similar to that of plain bars at corresponding temperatures. Joints tested at 500 degrees F. showed a maximum gain of 27.6 percent over joints of the same dimensions which were tested at usual atmospheric temperatures. On the net section of the plate the gain in strength due to this higher temperature was nearly 40 percent.

Joints which were strained hot and subsequently tested to destruction when cold were found to have retained the increased strength which they had at the higher temperature. The zone of maximum strength was in the vicinity of 500 degrees F. There was no decided loss in ductility of the joints at the higher temperatures at which they were tested.

The Applicability of Electrical Propulsion to Battleships, Together with the Experience Gained with it on the Jupiter

BY LIEUTENANT S. M. ROBINSON, U. S. N.

Abstract

The object of this paper is to show the best method of ship propulsion to be applied to battleships. It has been attempted to keep out all matters that do not bear directly on this one point. The *Jupiter* has been introduced merely to show the reliability of the apparatus that it is proposed to use. The Navy Department has authorized an electrical installation for the new battleship *California*, and it is believed that she will mark the beginning of a new era in marine engineering.

Briefly, the machinery for a battleship would consist of two turbo-generators running at a maximum speed of about 2,000 revolutions and generating current at about 3,000 volts, two switchboards, and four induction motors. The latter would be arranged with one on each of four shafts. The motors would be of the double squirrel cage type and the stators would be fitted with pole-changers which would give the motors two different numbers of poles and consequently two speed reductions. The motors would have two independent squirrel cage windings, the outer one having conductors of high resistance and the inner one conductors of low resistance. At high frequencies, such as would obtain in the rotor when starting up or backing, the inner winding takes practically no current due to its high resistance under these conditions; therefore the high resistance winding on the outside is the only one in operation and this insures a large torque for starting or backing. When running close to synchronous speed, the resistance of the inner winding is much reduced and it then operates like any ordinary squirrel-cage motor.

In choosing a method of propulsion for battleships, there are six points to be considered. They are, in order of their importance: (1) Reliability, (2) maneuvering qualities, (3) economy, (4) space occupied, (5) weight, (6) care and upkeep.

Reliability

Taking these points in their order, the first to be considered would be reliability. The reliability of induction motors and large high speed turbo-generators for land use has been well known for some time, but up to about one and one-half years ago had not been demonstrated on board ship. However, experience at sea with them has not developed any trouble, and their reliability is now unquestioned. There are several things that go to make an electric installation more reliable than any other. First, the installation is in duplicate throughout and the breaking down of one engine does not affect the ship except at high speed; it might be said that this is true of other installations, but it is not true in the same sense nor in the same degree that it is with the electric drive. For example, if one turbo-generator breaks down, the ship can still run in a perfectly normal manner up to a speed of about 19 knots. This would be impossible with any other mode of propulsion; even at speeds within the power of one engine on a twin screw ship the maneuvering qualities would become so bad as to handicap the ship; in fact, a twin screw ship operating with one engine would be able to reach port safely but would be of very little use in battle, whereas an electrically-driven ship, operating with one turbine would be just as good as any ship up to a speed of about 19 knots.

Then, too, there is the question of auxiliaries; with other forms of propulsion, if the auxiliaries in one engine-room break down, that engine-room may be almost entirely put out of commission. Of course the main air and circulating pumps are cross-connected, but when operating that way they are not very satisfactory and I have seen a battleship forced to stop because the forced lubrication pumps in the starboard engine-room broke down. If the ship had gone ahead with the port turbines, the starboard turbines would have revolved and burned out the bearings, so that it was necessary to stop the ship and repair pumps; with electric drive it would be a simple matter to shift to the other engine-room and make repairs without stopping.

There is one thing that makes the installation more reliable than other forms of turbine drive, and that is the fact that the turbine revolves in the same direction all the time. The importance of this cannot be overestimated, as it is believed by operating engineers that the greater amount of blading trouble that ships have had is nearly always due to the distortion that occurs when backing. There is also one other advantage when compared with reciprocating engines, and that is that the turbines would be less susceptible to damage by water when the boilers are priming. This fact has been thoroughly demonstrated by experience on the *Jupiter*.

Maneuvering

As regards maneuvering qualities, it is believed that the electric drive is far superior to any other method. This point will be taken up more in detail when the *Jupiter's* installation is discussed. It is rather difficult to describe these advantages on paper, but very easy to appreciate when you see the machinery working. Instead of big heavy throttles to open and close, there are light, easily handled oil switches, and a speed controller that can be handled with one finger. The engine-room watch required for a battleship would be just half what it would

be with other means of propulsion, as one engine-room would be idle practically all the time. In a rough sea there is no racing, with its attendant strains on machinery and on the personnel on watch. Any desired speed can be very quickly attained. The speed can be very accurately maintained and without any effort on the part of the personnel. These last two points are of very great importance on battleships when maneuvering in formation. The stand-by qualities are also superior to those of other installations, for at a very small expense in the way of steam the main turbine can be kept running very slowly

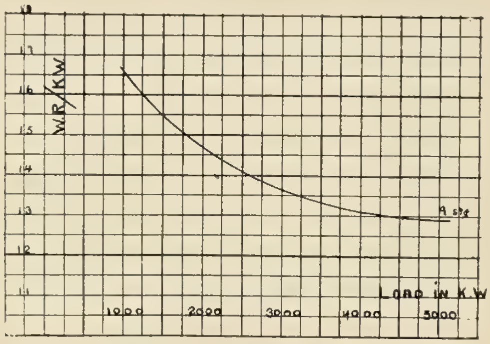


Fig. 1.—4,000 K. W. Turbine, *U. S. S. Jupiter*

and the engine-room is then ready to answer signals at any time; this might be of great importance to a battleship. The backing qualities of this installation are also superior to other forms, particularly turbine installations. It is possible to attain full power in the astern direction.

Economy

In considering the question of economy, we have reached the point which first suggested the use of electricity for the purpose of propulsion. None of the older forms of propulsion, such as reciprocating engines or direct connected turbines, can compare at all favorably with this method, the gain in economy being over 20 percent at high and cruising speeds. The only other method of propulsion that would appear to compete with this method in economy would seem to be the combination of high-speed turbines and reduction gears. The loss in the latter amounts to about 2 percent, while in the electric reduction gear the losses are from 8 to 9 percent. Mechanical reduction gears have been developed to a high degree, and it is very probable that in quite a number of cases the mechanical gears would be preferable to the electric drive, but as this paper is limited to a discussion of battleships that subject will not be touched.

For battleships I do not believe there is any question of the relative economy of the two methods—the electric drive is far superior. The electric reduction method possesses two inherent advantages that the mechanical method cannot overcome. First, the electric installation uses only one turbine at low powers; second, the induction motors are fitted with pole changers which allow the turbine to be run at normal speed with the ship cruising at low speed—in other words, the electric drive permits of two speed reductions while the mechanical gear has only one. These two advantages exist no matter how the two installations may be laid out, and they far outweigh the difference in the losses of the two methods. To show just how great these advantages are, two curves are shown. Fig. 1 shows the *Jupiter's* turbine operating under varying loads and Fig. 2 shows the turbine operating under varying speeds (and also loads). The load curve does not really show how very bad the conditions are for a battleship, as in that case the power at 12 knots is only about one-seventh what it is at 21 knots and the curve shown does not give so great a percent of reduction. It will also be seen that the speed curve is very steep at the low speeds and shows the bad effect of reducing turbine speed very greatly. As nearly all the cruising of a battleship is done at fairly low speeds, it is evident that the electric drive will be more economical than the mechanical gear.

In addition to the two advantages just stated, there are a number of other things entering into a comparison of the two methods that make it very doubtful if the mechanical gear would be as good, even at the high speeds, as the electric reduction. It would probably be necessary to use at least four turbines with a mechanical gear instead of two, as with the electric method; this fact alone would make the electric reduction the more efficient of the two. Then there are also the very considerable losses due to the friction and windage of the backing turbine. According to Sir Charles Parsons this loss amounts to about one-half a percent. Also there would be a saving due to the fact that only one set of auxiliaries would be used at a time.

Space Occupied

As regards the actual space that the machinery would occupy, the electric drive would take up less space than any other installation, with the possible exception of the mechanical gear. The arrangement of the machinery, however, is so much more flexible with the electric drive than with other methods that it is probable it would occupy less space than would the gears. It lends itself very readily to watertight subdivision.

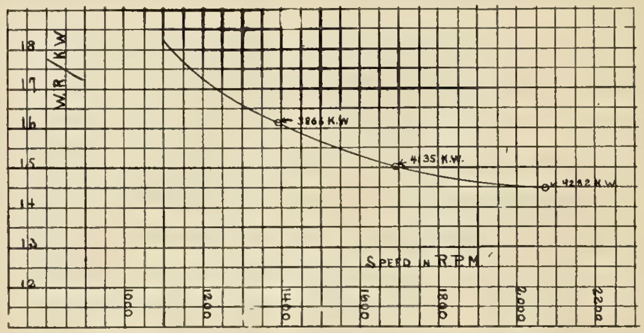


Fig. 2.—4,000 K. W. Turbine *U. S. S. Jupiter*

Weight

The next point to be considered is that of weight, and here again the electric drive is superior to any other method with the possible exception of mechanical gears. It is rather difficult to say exactly how the two methods would compare either as regards space or weight, as a great deal would depend on the number of turbines used with the mechanical gear in order to get 30,000 shaft horsepower. However, if the largest sizes of geared turbines now at sea are any guide, the weight of the electric drive would be less than the weight of the geared turbine.

Care and Upkeep

As regards care and upkeep, the electric drive is greatly superior to either reciprocating engines or direct-connected turbines, also due to the fact that the turbines do not have to reverse, it would be superior to the geared drive in that it would have less blading trouble. Either of the two latter methods, however, is very satisfactory

in this respect, as a high-speed turbine is so small that it is easily handled and repaired by the ship's mechanics.

This completes the case of the electric drive for battleships; all of the points have been considered and in every case it has been seen that it has no superior. There are, however, some points that have been made against electric propulsion, and these will be taken up before proceeding to a discussion of the *Jupiter's* installation. First, there is the danger from large quantities of water in the engine-room; however, this danger is more fancied than real, as all the wiring could be placed well overhead, being taken out of the tops of the motors and generators. The generators could be placed high enough to insure their safety and the motors could be placed in watertight pits so that the engine-room could have enough water in it to put the auxiliaries out of commission before reaching the main engines. The next point is that, when operating with one turbine, all motors must run at the same speed if they run at all; this fact has been found to be no handicap in actual operation. The next point is that, in turning, the inboard screw does not slow down; this slightly increases the turning circle, but does not increase the space necessary to turn in, as the inboard screw can always be stopped or backed.

The equipment on the *Jupiter* is similar to that which would be used on a battleship, so it offers a good example of many points that have been advanced in favor of the electric drive.

U. S. S. Jupiter

The *Jupiter* has been in commission over a year and a half. During that time she has conducted two official trials and has carried on the usual routine work of a navy collier. She has steamed about 14,000 miles and has been handled a great deal around docks, in narrow channels, and other places where a great deal of engine handling was required. About one-half of the steaming has been done in the tropics with circulating water over 80 degrees F. and with correspondingly poor vacuum, so that the ecenomy of the ship is known under all conditions. The fuel economy has proved to be excellent, being, on the average, about 25 percent better than the best of her sister colliers.

During the whole period of commission, two repairs have been made to the main engine. The first was to reblade the first stage of the turbine. This work was done entirely by the ship's mechanics. The first stage blading was injured by a bolthead from the segment carrying the fixed blading. The bolt was broken off, probably through having been set up too hard while assembling. These bolts were all tap bolts and have been replaced by filister head screws with countersunk heads and a repetition of the accident would not be possible. The accident, however, was in no way peculiar to the electric drive, as it might very well have happened to any other engine. The other repair was to replace one of the porcelain cylinders which carry the resistance; this cylinder was cracked when the ship went into dry-dock, but it was never discovered whether the cracking was due to the oiler putting undue pressure on the cylinder or due to some strain brought on it when the ship settled on the keel blocks. At any rate the damage was repaired by two machinists in about two hours.

The amount of work expended in keeping the equipment in condition has been very small. After coming in from a run, the turbine clearances are taken to see if they have changed; and the motor clearances are also checked; there has been no change in either of these clearances up to date. Before getting under way the holding-down bolts of the turbine are gone over to see if they are tight, the slip rings on the motor of the generator are examined to see if they are clean, and all insulators are also examined for cleanliness, all connections are generally gone over to make sure they are tight, the oil switch boxes are examined to see if they have the proper amount of oil, and the governor control-valve springs are tested to see if they have the proper tension. After starting the turbine, the emergency trip is tested. In port the oil pump is run once a week to force oil through the turbine bearings and the motor shafts are jacked daily. Due to the fact that the main condenser is used a great deal (the auxiliary condenser being too small to handle the coaling winches), the small pump for draining the turbine casing is run for a few minutes each day when in port to make sure that no water may be allowed to accumulate in the turbine.

In operation the *Jupiter's* engines have been highly satisfactory. There has been only one time when anything has happened during the handling of the engines and that was the tripping out of an exciter. The lighting set was immediately put on for exciting and the engines were ready to use again in about one and one-half minutes. If such an accident were to happen again it would take even less time, as the men are more familiar with the installation. At the time the accident occurred the ship had just left the navy yard for the first time.

The handling of the engines has been proved more than once; the ship has been handled a great deal in narrow waters and around docks. She steers very badly at times and the quick response of the engines has more than once helped in getting out of difficulties. The engines have been used to swing ship for compass deviation without putting any way on the ship at all, the total space used for swinging being little more than the ship's length.

The ability of the turbine to stand severe abuse from water has been demonstrated several times. There is no separator on the main steam line, and several times the boilers have primed and carried considerable water over into the turbine. This was particularly noticeable during dock trials, when it was impossible to properly handle the boilers. The only indication the turbine gave was an increase in the first stage pressure and a rattle in the casing as the water was hurled through at a high rate of speed, but the turbine blading showed no signs of bad effects from this.

The backing qualities of the engines have proved to be all that could be desired; if the ship is cruising with the resistances in, the time taken for reversing is practically nothing at all; if the resistances are out, it takes a few seconds—not more than three.

When underway the engine-room is very cool, due to the fact that the generator is fitted with air impellers at each end which take their suction from the engine-room, thus insuring a good circulation of air.

After all, the greatest test of the satisfactory working of any machinery is whether the men who are actually handling it and caring for it are pleased with it. If this test applies to the *Jupiter's* machinery it certainly is an unqualified success. In particular is this true if the matter is referred to the coal passers in the fire-room who have to handle much less coal than do the men on sister ships. The ship can make her contract speed of 14 knots without using forced draft at all.

Submarine Signalling and Proposed Method of Safe Navigation in Fog

BY COMMANDER F. L. SAWYER, U. S. N.

Abstract

The purpose in this paper is to present a proposed method of avoiding collision when navigating in fogs. The sole means of avoiding collision in a fog at the pres-

ent time is that prescribed by the "Rules of the Road"; namely, the fog whistle or siren. So far as range, efficiency and reliability are concerned, these fog signals have made no appreciable advance since our largest men-of-war used steam as auxiliary to sail power. The present methods of navigating vessels in a fog are totally inadequate to insure reasonable security to life and property and the danger of collision in fog always exists.

A satisfactory system of fog navigation would require:

(a) The presence of another vessel to be ascertained at least as far as the steamer lights are visible—namely, five miles.

(b) A knowledge of the course and speed of the other vessel.

(c) Information as to whether or not the bearing of the other vessel is changing without changing the speed and course of either vessel.

(d) Ample sea room to change course in case such maneuver is found necessary.

(e) Simple means and apparatus involving no calculations or estimates to be made so that an intelligent navigator can carry out the method.

In order to accomplish the above, the method proposed contemplates the use of the simplest form of wireless with any efficient form of submarine wireless. In case of fog simultaneous signals are sent from a vessel and only a single letter or number in the Morse code is necessary to be sent. The twenty-six letters and ten numbers each represent ten degrees of the compass, so that any course is signaled to the nearest five degrees, with an average error of less than one-quarter of a point. The observer using an ordinary double head-piece receiver on another vessel receives the wireless signal and submarine wireless signal, but not simultaneously, as the former is instantaneous, while the latter, at five miles distant, for example, arrives more than six seconds later. This very considerable interval renders it easy to measure the distance between vessels with greater accuracy than necessary for purposes of navigation. After arriving within range of the submarine wireless signal, the vessels are able to know at all times their distance within an error that should not exceed 300 yards.

In the practical application of this method at sea, a standard wireless installation might be used, but such range and power are not required. A short wave length of not more than 200 meters, such as is reserved for the use of amateur operators, would be sufficient for the purpose. An inexpensive set with a variable frequency would be practical, by which the changing pitch and single letter would indicate an unmistakable fog signal. There would be no danger of interference with submarine signals. If more than one vessel were within the field of audibility, the variations in speed or course would eliminate any probability of confusion.

The recent simultaneous tests of the Berger and Fessenden submarine systems have shown an effective range of ten miles for both. A range of five miles should show four times this intensity, and, therefore, this element in the system appears to be solved.

The method above outlined appears, therefore, to furnish the information necessary for safe fog navigation, namely, at a range of over five miles, speed and course of other vessel, whether her bearing is changing, sea room to maneuver if necessary, the condition that both vessels are liable to hold their course and speed until bearing change is ascertained, and, in addition, the distance separating the vessels. Vessels having this knowledge will in nine times out of ten find themselves passing more than one mile apart without either changing their course or speed.

Naval Engineering Ship Models

BY FRANK VAN VLECK, PH. D.

Admirers of things nautical and naval, when visiting Washington, often seek out and study the beautiful ship models to be found in the corridors of the Navy Department and in the marine section of the Smithsonian Institute. There is no colleection equal to these two anywhere in America, and but few in Europe. In addition, there are a few excellent ship models in the hallways of the Treasury Department, illustrating the fine vessels of the Revenue Cutter Service. In the Post Office Department a few large and unusually well-developed models are shown of a few of the representative ships of the mercantile marine, as used for the transport of United States mail. These ships, however, fly foreign flags. The United States War Department has also had executed some good models of military transports, showing the complete ships and longitudinal inboard sections.

Should all of these models be gathered together they would make a marine exhibit which would attract profound attention even from those who are not specialists in naval architecture. Many of these models are being prepared for shipment to San Francisco for exhibition at the Panama-Pacific Exhibition, and will attract deserved approbation from the public at large.

But why along with these beautiful hull models should we not also have carefully executed models of the propelling machinery of our naval vessels? Because an officer cannot serve with sword and epaulets in the superheated atmosphere of a boiler or engine room does not signify that the machinery in that space is unworthy to be exhibited to a people who demand to know what makes the vessels plow the seas so majestically. The precedent for such models, which the Navy Department should not ignore, is the fact that the Revenue Cutter Service already has on exhibition in the corridors of the Treasury Department at Washington three or four excellent models of marine engines built on a scale of one inch to the foot. Captain C. A. McAllister, engineer-in-chief of the Revenue Cutter Service, has taken great pride in working out the details of these splendid models, and has stated that he now has more of them in preparation.

As an educational feature, working models of marine machinery are essential, especially when the opportunity to inspect the actual machinery itself on board ship by the people throughout the country whose money has paid for this construction is very remote. Will not their knowledge, appreciation and enthusiasm be greatly enhanced by the existence of such models in public places, even if only a few of them are professional mechanics and understand the details of such machinery?

Some slight familiarity with the complicated details of the machinery of monster battleships will bring to the uninitiated layman some realization of the existing importance of the ultimate training of the naval engineer officers who are called upon to control this machinery. Steam engineering, not seamanship, must win the battles of the future. A captain in action, fighting for the weather gage to get in his broadside, can no longer thrill his crew with his hoarse commands of "Rightabout," which will bring his ship to its best fighting position, but rather will it not be the captain who is an engineer who will win the battle—a man who in distress gets 19 knots out of an 18-knot engine? To convince the world that the man on the quarter-deck must be an engineer, is it not wise to show the people the intricate machinery below decks?

Werkspoor Motor Ships in Service

Working Results of Nine Diesel-Engined Sea-Going Vessels—Mishaps that Have Occurred and Their Causes

BY T. ORCHARD LISLE, A. M. I. MAR. E.

At the present time there are just under one hundred commercial ships of over 300 horsepower fitted with Diesel oil engines as propulsive power, the majority of which are equipped with motors of the four-stroke type, and which undoubtedly are giving reliable and regular service. Yet, because about a dozen motor craft that have been brought into the limelight have proven far from satisfactory, there has been a tendency among some shipowners to treat lightly the use of the Diesel engine for ocean-going ships, instead of giving the deep thought and discriminate consideration that it deserves and demands, and inquiring properly into the ulterior reasons thereof. It was this self-same tendency to light treatment by some marine engineers and shipbuilders that has been the main cause of the non-success of a few modern motor ships. There also has been a distinct tendency to overrate many of the machinery accidents.

If more discriminate probing was done by shipowners, and less attention paid to rumors and hearsay, the marine Diesel engine as a commercial proposition would stand far higher in the general estimation than it does to-day. It is important to notice, however, that there are certain shipowners who have practically abandoned coal and oil-fired boilers because of the splendid and economical service that they have obtained with Diesel engines. These owners have the warmest regard for this particular type of power after many years' sea-going experience, which it fully deserves. To quote a few names—The Anglo-Saxon Petroleum Company, The East Asiatic Company, The Nobel Brothers Naphtha Productions Company and the Mercury & Caucasus Transportation Company are such firms.

Curious and interesting reflection is offered by the fact that of the 100 motor ships in service just about one-half were completed before and during 1910, up to when the highest powered two-stroke engined vessel was 360 horsepower compared with 1,200 horsepower for the rival type of motor. These vessels all seem to have given excellent service, and it is only during the last three years that serious troubles seem to have occurred. It is during the latter period that the high powered two-stroke driven ships have joined the steadily increasing list of active motor vessels. Judging by working results I firmly believe that the two-stroke marine engine will most likely meet with its best success in small powers, say 100 to 350 horsepower (if it can compete with the hot-bulb engine), and not in high powers, which is contrary to the general opinion that, by the way, was rashly formed before proper data were available, and partly due to misleading and harmful matter unwittingly published by some of the semi-technical and non-technical journals and magazines.

Serious Troubles Confined to Two-Cycle Engines

Investigation will show that where serious trouble has occurred under sea-going conditions it has been almost absolutely exclusive to the two-stroke type of engine, and due chiefly to heat and bearing issues, which are the outcome of high powers and their relation to the principle of this particular cycle, and have no reflection on the four-stroke Diesel engine. Yet it unfortunately has been made so. But it is not my intention to discuss at length here the pros and cons of the two types, so I will content myself with facts and, by stating that while the two-stroke Diesel engine is still in the experimental stage, the single-acting, four-stroke Diesel is a proven commercial success. Also it is most significant that while many shipowners have given frequent repeat orders for four-stroke Diesel engine-driven ships, there is not a single instance on record of the owner of a two-stroke Diesel-engined commercial vessel having given a repeat order after he has had his first ship in service several months. This needs most careful reflection.

I may add that after many years spent closely watching the development of both types in Europe I have personally reluctantly come to the conclusion that in this decade the marine two-cycle Diesel engine will not become superior to the four-stroke model for commercial ships, although it very probably will be extensively used for naval work, where the question of space, economy and weight are the most important considerations irrespective of protracted duties and running economies. The various admiralties can afford to continue spending fortunes experimenting, but the shipowner and marine engineer cannot, because of the dividends that they must earn, so the lead of admiralties should not be blindly followed. However, the huge economies resulting from the adoption of a proven propelling power make it highly desirable and even imperative for every shipowner definitely to make sure that the four-stroke Diesel engine will, or will not, be advantageous for his individual vessels. There need be no hesitation over the reliability question, for this propulsive power has to-day reached a stage where such firms as the Werkspoor Company, of Amsterdam, and Burmeister & Wain, of Copenhagen, are erecting and installing, under special circumstances, Diesel engines of over 1,000 horsepower per shaft straight into the ships without any previous shop trials. Furthermore, vessels are going on long ocean voyages with as little as three hours' sea trials, and as yet the builders and owners have had no cause to regret the implicit confidence thus placed by them in oil engines. No praise could speak so favorably as this.

At present we can take it as definite that the four-cycle engine is in the van. True, the two-cycle may be improved considerably in time, but the four-stroke also will go on improving, and it already has a great lead that will be difficult to overcome. It is up to the shipowner to decide whether he will adopt a proved commercial success, or machinery with which success is by no means assured, just for the sake of a little extra power. This extra power does not seem to be much, although in theory the difference is great, because there is very little chance in the near future of a two-cycle engined ship of high power being able to run for 20 and 30-day voyages with the throttle full open, and certainly not at the present stage of developments, if I may take existing results as a criterion.

A Marine Superintendent's Views

It is the view of Mr. C. Zulver, the marine superintendent of the Anglo-Saxon Petroleum Company, which owns many motor ships, that, "although aware of the general tendency in favor of the two-stroke cycle (principally because of the attractiveness of the increased power of

similar cylinder dimensions), one has to consider reliability for continuous work under varying conditions at sea, and in this respect the four-cycle has proved superior. We have the outcome of twelve years' experiment and research, and to sacrifice to some measure this valuable experience in order to build two-cycle engines does not, from a commercial standpoint, appear by any means to be a wise course at present."

I am enabled to give the working results of nine ships that have been installed with Werkspoor four-stroke type Diesel engines, with details of the various slight mishaps that have occurred on different voyages. The revealment of this information will, I hope, do much to allay the fears that large heavy oil engines cannot be relied upon under severe or general conditions of ocean-going work. Business competition naturally was a factor in preventing these data from being publicly discussed previously, and the stage now reached eliminates all necessity for semi-secrecy. These reports are based on information furnished by the owners.

First of all I will deal with the *Vulcanus*, for she was the first real ocean-going vessel, outside of Russia, afloat. She was placed in service by the Anglo-Saxon Petroleum Company of London in 1910, and after over five years' steady work is still giving excellent service. She is a full-lined vessel of 1,900 tons displacement, with an oil-carrying capacity of 1,000 tons, and her direct-reversible Werkspoor 450 horsepower engine gives her a speed of 8½ knots.

The marine superintendent of her owners estimates that her total saving to them over steam has been about $11,000 (£2,250) per year, although she is but a small boat. During her first two years' service she covered about 45,600 miles, and her engines made over 12,000,000 revolutions, yet the wear on the cylinder liners was exceedingly slight. The fuel consumption was not over two tons per diem.

Being a pioneer craft and designed six years ago, the engines of *Vulcanus* were frequently overhauled for examination by desire, and not necessity; but after long voyages everything was usually O K, sometimes a few piston rings were renewed, and sometimes the precautions were taken to re-grind or renew the exhaust valves, although the latter have given no trouble. While exhaust valves are usually considered to be a weak point of four-cycle Diesel engines, no inconvenience or delay has ever been caused in this respect. Occasionally trouble was given by the air compressors.

Mishaps to the Vulcanus

Only on one occasion had the *Vulcanus* to be assisted. On her third voyage to Hamburg the brick lining of the exhaust pipe collapsed, partially choking the exhaust passage and so reducing the revolutions of the motor. The engineer not knowing the cause, and still under the influence of his steam engine training, further opened the throttle, thereby considerably overloading and choking the motor, etc. She was towed from the Elbe lightship to Hamburg and was held up for four days under repair.

On another voyage there was a bending of the crankshaft, due to a bottom end bolt breaking and fouling the crank. The latter was due to a careless overstraining of the connecting rod bolts during an overhaul by a firm which was not the builder of the engine. However, the bent shaft and disturbed timing did not prevent the *Vulcanus* from running another three months, when a new crank shaft was put in.

Another accident was the exploding of an inblast air reservoir, while the engines were being overhauled at the builder's yard at Amsterdam. Bad welding had left a fracture, and the top part of the air vessel blew right off, causing the second engineer to lose his left arm—a most distressing and unfortunate occurrence, but which was not directly due to the engine or its builders. The indirect cause was the accumulation of water in the air retainer, which had not drained owing to a cracked internal pipe. This mishap taught the builders of the machinery to dispense with welded air bottles and suspend them with covers and valves downward, thus effectually preventing any unknown accumulation of water.

In summing up these little accidents it should be borne in mind that the makers of the engines of the *Vulcanus* at the time had no experience of high sea service upon which to base their designs. With later ships advantage was naturally taken of this first experience, and consequently very little trouble has ensued. As a matter of fact the Werkspoor Company guarantees reliability with present-day engines. On her first trials, by the way, the only man in the engine room for some hours was a representative of a London engineering paper, the engine room crew suffering from an attack of sea-sickness. Yet there was no governor on that particular engine, and everything worked sweetly.

Record of the Juno

The *Juno*, a tanker of 2,450 tons deadweight capacity, 4,200 tons displacement, and fitted with a six-cylinder 1,100 horsepower Werkspoor Diesel engine, left Rotterdam on her maiden voyage to Braila (Black Sea) on November 22, 1912, arriving on December 15, having used for all purposes 86.21 tons of oil fuel, or 3.75 tons per day, and made an average speed of 9 knots. She spent seven days in port under overhaul. A few piston rings were found stuck, otherwise everything was in good condition. Her auxiliaries are driven by steam, generated in a donkey boiler, partly fired by the exhaust gases from the engine and partly by an oil burner. This has been done with success in all later Werkspoor vessels, except that the heat from the exhaust has now been found sufficient for the purpose. The fuel consumption of the *Júno's* engines has since been reduced, and it works out at 0.3 pound per indicated horsepower hour, which is about 17 percent lower than with two-stroke engines of similar power.

It has been found possible, by reason of the great accessibility afforded by the design, to examine and clean all the pistons of the *Juno's* engines without disturbing any cylinder heads, pipes, valves, cams, etc. The *Juno* has since been in regular service, and Mr. C. Zulver, marine superintendent for the owners, the Anglo-Saxon Petroleum Company, stated that "the plain, unvarnished truth is that her engines gave very little trouble indeed, wear and tear of moving parts being very slight, and less than is usually found in marine engines." A little difficulty was at first experienced with cooling pumps, through the capacity having been based on land practice and proving insufficient. All these minor mishaps, already referred to and as follows, have been a splendid education for the builders of the engine, and the lessons learned are used to advantage in present-day ships, and they are indebted to the co-operation of the various owners in assisting them to make good.

A year previous to the *Vulcanus*, the Werkspoor Company installed Diesel engines of about 200 horsepower in the small ships *San Antonio* and *Sembilan*. Even at this early period these vessels gave good results (and still run excellently). In 1911 one of the voyages of the *San Antonio* was from England to Brazil and Venezuela and back.

I will next refer to the *Loudon,* owned by the Royal Packet Navigation Company of Amsterdam, a cargo and passenger ship of 1,750 tons deadweight capacity, and propelled by a 1,100 horsepower Werkspoor Diesel engine of the four-stroke type, and which commenced her maiden voyage on November 22, 1913, from Amsterdam to Batavia, arriving on December 31, having averaged over 10 miles an hour. The chief engineer reported that, when between Amsterdam and Flushing, the flow of lubricating oil diminished, which was soon found to be due to clogging of a pipe in the filter and was quickly remedied.

Another minor mishap was experienced on account of some very heavy oil fuel having been pumped in error to the solar oil filter. Naturally this fuel was too thick to follow the speed of the fuel pump, and the engine slowed down. Shortly after the machinery was stopped in order to drop the pilot, and the engine would not restart on the heavy oil, as the adjustments were not suitable. But after draining the pipes and filling them with solar oil, the trouble was over. It is rumors based on such little accidents as these, and which increase in seriousness as they pass from person to person, that do so much harm to the Diesel engine industry. As a matter of fact, the engines really worked excellently, no hot boxes occurring, not even on the first few days when the ship was rolling heavily.

After arriving in the East Indies the *Loudon* regularly plied between different ports in the Dutch colonies. On one voyage, from Batavia to Palembang, she spent 4 days and 5.3 hours loading and unloading in the different ports en route, while the actual running time was 2 days 18.9 hours. There were no standby losses, other than wages and food, but a steamship would have had exceedingly high stand-by losses, because of the necessity for keeping up a head of steam.

Later Vessels

Very fine performances have been given by the *Artemis,* a ship of 7,720 tons displacement, and 5,050 tons deadweight capacity, fitted with two 1,125 indicated horsepower Werkspoor four-stroke Diesel engines and owned by the Anglo-Saxon Petroleum Company. On April 7, 1914, she left Rotterdam on her first voyage, bound for Constanza, returning in May. In June she left Rotterdam for Shanghai, reaching Alexandria en route twelve days after (average speed 11 miles per hour), and her destination was reached towards the end of July.

A few troubles were experienced underway, consisting of several hot crank pins and crosshead brasses, which were scraped up and adjusted in port. These mishaps were due to the use of lubricating oil that proved too thin. Since then a more substantial oil has been used and the troubles of *Artemis* were over. Her total fuel consumption averages not over 7 tons per day, which the marine superintendent of the owners wrote saying was a marvelous performance for a ship of her size and power. He went aboard at Port Samboe on July 18, and the following is an extract from his report:

"On the arrival of the *Artemis* at Port Samboe on July18, we went on board and are pleased to say that our high expectations of the Diesel installation of this ship had not been disappointed. We noticed the various improvements with great interest and satisfaction, and the chief engineer informed us that he had experienced no trouble with the engine except a few crankpins and crosshead brasses, which he scraped up and adjusted here."

It may be remembered that a new piston-cooling arrangement was devised by the Werkspoor firm a short time ago, and in this connection the superintendent states that "it works quite well and gives no trouble." He further adds that "it is gratifying to learn that sufficient steam (for the auxiliaries) can be raised with the exhaust gases, thus creating a substantial saving in the oil fuel bill."

A sistership to this vessel is the *Ares,* which carried out her trial trip on May 19 last, when a speed of 11¼ knots was attained, that is to say, about one knot over the guaranteed speed. On the same day as she ran her trials she sailed for Rotterdam, where she loaded and left on May 28 for the Black Sea. She had to put in at Lisbon Harbor on account of lubricating oil, a mistake having been made in the quality, which was found to be far too thick.

On July 10 the *Ares* returned from the Black Sea to Rotterdam, having made a run of 3,634 miles in 16 days at an average speed of 9½ knots, which, with the exception of stopping the starboard engine to replace the chain which drives the cylinder lubricating pump, was a non-stop run. In the same month she sailed for the East Indies.

The third sister boat, the *Selene,* ran her trial trip on August 29 last, and sailed for Port Arthur, Texas, on September 5, which port she reached on September 27. Owing to the mines which were laid in the North Sea, the trials of this boat were of exceptionally short duration (three hours moored and four hours at sea), and after this very short trial the ship left for a 22-days' voyage. The engineer's report mentioned great satisfaction with regard to the heating of the boiler by the waste gases and the consequent lower fuel consumption.

On days when there was fine weather a speed of nearly 11 knots (ship unloaded) on a fuel consumption of only 6¼ tons (2,250 indicated horsepower) was attained, which was even better than the performance of the *Artemis.* This includes everything needed for the auxiliaries, such as the steering gear. The Werkspoor installations, by the way, appear to be the only ones at present existing in which the exhaust gases are employed for raising steam for the steering engine and pumps with such satisfactory results. The *Artemis* stayed at Port Arthur for four days loading and making adjustments to the engines, this being necessary owing to the short trials referred to.

Finally, but not least, is the *Elbruz,* a sistership to the twin-screw vessel *Emmanuel Nobel,* which was placed in service a year ago. Both vessels are of 6,230 tons deadweight capacity, and are equipped with two 1,100 horsepower Werkspoor four-cycle Diesel motors.

The *Elbruz* was commissioned in July last and, it is interesting to note, her engines were installed in the hull without even turning round in the shops under power. After a few hours' tests when moored she ran her trial trip, and the following day she started for Constantinople, reaching there 13½ days later after a successful voyage without particular incident.

Having fully explained the slight mishaps that have occurred to various Werkspoor-engined motor ships it is to be sincerely hoped that shipowners will fully realize that they can without the slightest trepidation or hesitation place an order for a commercial ship with carefully selected four-stroke Diesel motors as the propulsive power, and be sure of obtaining the same reliable service as they are accustomed to having from steam.

Before concluding there is one important query that should be made clear, namely, the desirability (?) of specially trained men in the engine room. In connection with this I would point out that it has been stated by the marine superintendent of the Anglo-Saxon Petroleum Company that "their experience is that any marine engineer of ordinary intelligence and experience can soon become capable of running and handling a Diesel engine installation, and

it is certain that no special or highly skilled men are necessary." This assurance, coming from a marine engineer of extensive sea-going experience, and who is in charge of a large fleet of steam and motor vessels, will no doubt give a strong impulse to the more general adoption of Diesel engines for ship propulsion and satisfy shipowners on that score.

Tank Ship Construction*

BY ROBERT WHITING, MORRELL, M. E.

Each bulkhead usually has two or three vertical web stiffeners, which should be on the same side as the bulb stiffeners, as it is very bad practice to put any stiffeners on the calking side of a bulkhead. These webs are slotted out to fit around the bulb stiffeners, and are clipped to the bulkhead by short clips between the horizontal bulb angles. The webs, consisting of plates, face bars, and short horizontal clips, are assembled and riveted separately on the ground; but the clips connecting them to the bulkhead should be rivted to the bulkhead. The webs can be riveted complete, except for the short horizontal clips which catch the bulb stiffeners, and also the face bar should be left loose for a short distance, top and bottom.

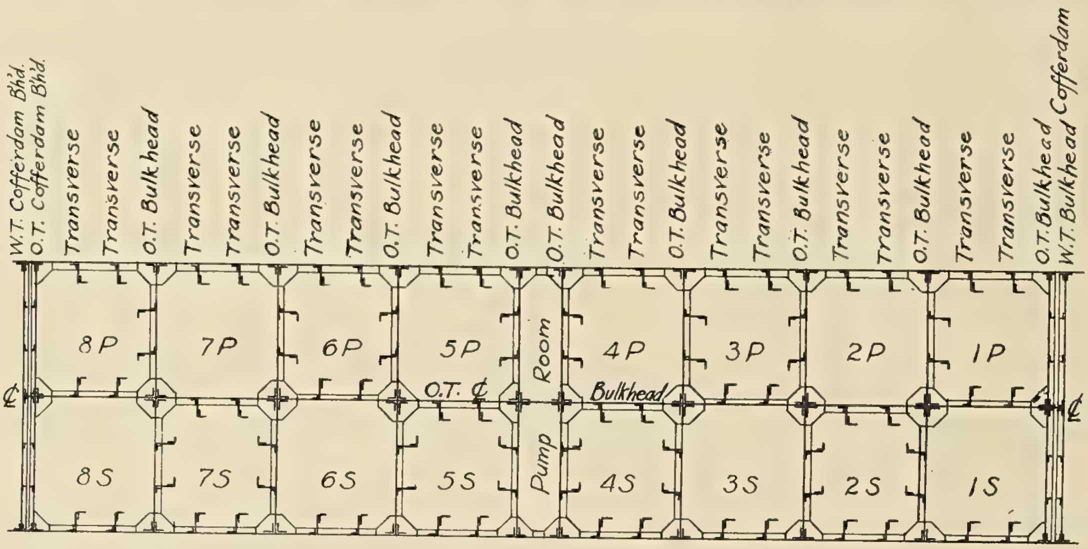
It is advisable to cut a small door or manhole in each bulkhead for convenience in access to the various tanks without having to climb over the bulkhead to get from one tank to another during the course of construction. Later a cover plate can be riveted on this opening.

It is a great advantage to do all possible riveting and calking on the ground, but the work should first be checked by battens for half widths and heights. The bulkheads can be riveted on the ground complete, with the exceptions noted above, and are then ready for shipping. The bulkheads on the side of the ship away from the overhead crane, if of the cantilever type, are apt to be too heavy to lift in one piece, and should therefore be broken in half at a seam in the plating.

A ribband should be run at the main deck to catch the bulkheads, and diagonal braces should also be used. One or two vertical ribbands should be bolted to each bulkhead.

Just as the calking side of the centerline bulkhead reverses in adjacent tanks, so the calking side of the transverse bulkheads reverses on opposite sides of the ship, with a few exceptions. For example, starting at the forward end the forward bulkhead of the cofferdam has its calking side forward, both port and starboard, while the after bulkhead of the cofferdam has its calking side aft, port and starboard. This is necessary, as these bulkheads have vertical webs in common, which must be on the non-calking side. But the next bulkhead aft has its calking side forward on the starboard side and aft on the port side, while the second one has just the reverse. If the pump room is amidships, the calking sides of both pump room bulkheads should face into the pump room, in order to keep the stiffeners out of that space.

This feature causes complications in shipping the bulkheads, for it will be found that it is not feasible to put them all in the ship at this stage of the construction; in fact, only half of them can be shipped. The reason is a roundabout one, and difficult to follow, but stated as simply as possible it is that any given bulkhead cannot be put in on both port and starboard sides without first having the centerline bulkhead plating between the two parts; and this plating can not be hung in place until the transverse or belt frames are in the ship (on one side only in each tank), to attach the centerline plating to. Therefore, the situation is that we can put half the bulkheads in the ship, and simultaneously we must have half the transverses ready to put in.



Diagram, Showing Arrangement of Bulkheads and Transverses in Oil Space

The transverses can be assembled on the skids to advantage. It will be seen that they are not symmetrical, for on the non-calking side of the centerline there is a web, with slots to take the centerline stiffeners. These frames are the ones wanted first. The entire frame is notched or slotted to take shell longitudinals, deck longitudinals and centerline stiffeners. Lloyds require that the corners of these slots must be punched round to prevent tearing. They also stipulate that the butt laps of the plating must come between slots, and that the lightening holes must be nearer the face bar than the outer edge.

The frame is connected to the shell, deck and centerline by clips between the slots. If possible, these clips should be made single, as double clips cause much trouble on the skids. The best practice, instead of working these connections as short clips, is to work them as continuous bars and cut them out at the slots after riveting. This, of course, causes considerable waste of material, but has many advantages to offset this fault.

Clips are likely to get lost when most wanted, and they would require fairing clips to keep them in line for rivet-

* Continued from the December Number.

ing, and even then would be apt to be unfair. At the turn of the bilge it is much cheaper to joggle, bevel and bend a continuous bar than a collection of clips. By sawing through the shell flange at each slot the chipping on the skids is reduced to a minimum. No holes should be put in these bars where they cross shell seams. They should be joggled in way of outside strakes.

The transverses can be riveted complete on the skids, with the following exceptions: the shell clips next the centerline and the deck should be left loose, and if the bilge strake of shell is a skin strake the shell clips at the turn of the bilge should be left loose, the top and bottom clips to the centerline should be left loose, and the outboard deck clip. No riveting should be done until the frame has been carefully checked by half width and height battens. It is even then advisable, but not necessary, to leave one butt lap loose. In working the big brackets at the turn of the bilge, they should be sheared before the slots are punched, for if the slots are cut out first the plate will curl up between slots when sheared.

Having the solid transverses ready on the non-calking side of the centerline they can be put in the ship. The next step is to place the centerline stiffeners in the slots in these frames. At the bottom the vertical keel closes the slots and makes it necessary to reeve the stiffener through. Here it becomes apparent why a careful selection of the bulkheads to be put in the ship is necessary; for unless these bottom stiffeners are placed in their slots before the bulkheads are shipped, it is evident that if the bulkheads are in place at both ends of the stiffener it will be impossible to reeve it through. A similar condition exists at the bilge if the bilge shell is a skin strake. In this case it is cheaper to place this strake on the spauls before the transverses are shipped than to pull it up into place afterwards; but the shell longitudinals can not be placed on this strake, or the transverses could not be entered, hence it is necessary to reeve the bilge shell longitudinals through the slots.

Fitting the Centerline Plating

With the centerline stiffeners in place, the centerline plating can be hung. This plating should be designed to have a narrow vertical plate at each bulkhead, in order to do away with linering the bounding angles. (This idea is also applicable to the transverse bulkheads, but its value in that connection is questionable.) Between the vertical plates the centerline bulkhead is worked in horizontal strakes, with joggled seams, the joggle dying out at the end of the plate.

The lap of the plating on the vertical keel may be joggled, except in way of bulkheads, where it dies out and tapered liners are used, as it is almost impossible to make a tight fit of the bounding bar around the joggle. The joggling should always be toward the calking side, except at the lap of the vertical keel, where it must remain always on the same side of the ship. The vertical plates are joggled to receive the ends of the horizontal strakes. The joggling is very complicated and should be watched closely, as in some cases a plate will joggle in opposite directions in a space of two feet. On account of this difficult joggling the stiffener next above the lap of the vertical keel should be kept as far above the lap as is feasible. All the stiffeners should heel down.

The question of assembling the sections of horizontal plating between the vertical plates on the ground has been considered, but owing to the reverse joggling and the stiffeners extending beyond the ends of the horizontal strakes the difficulty in shipping these sections when assembled is so great as to make it unadvisable.

After the centerline plating is completed the remaining bulkheads and transverses can be shipped. These transverses are the ones on the calking side of the centerline, and have no centerline web. A heavy vertical wooden strut should therefore be bolted to the frame near the center line, to hold it to the proper height. These transverses are connected to the centerline by big brackets, usually having double clips. As these clips cross the lap of the vertical keel, where the joggle occurs, it is best to cut away the centerline flange of the clip clear of the joggle to permit better calking. There is a tendency to extend these clips about six inches beyond the tip of the bracket, taking two more holes through the centerline than through the bracket. With double clips this leaves a space between the heels which can not be calked, and is therefore bad practice. It can be made tight by "gun-

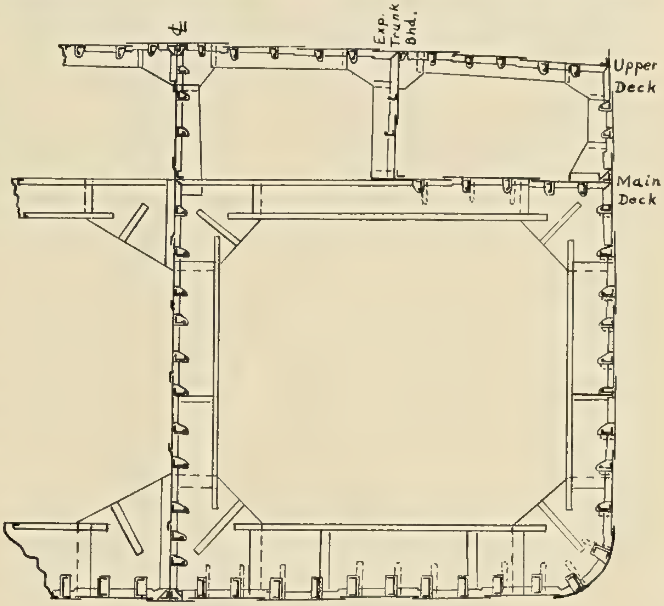


Diagram of Transverse in Oil Space

ning," which, although very efficient, is costly and is condemned by many inspectors and should therefore be obviated in the design as far as possible.

Bilge and Side Shell Longitudinals

The next step is to ship the bilge and side shell longitudinals. This is a difficult job for the riggers, especially where the bars are not straight. It is necessary to pull back or cut off the staging spauls, lower the bar down by means of the crane, then with tackles pull it into its slot. It is highly important, from the rigger's standpoint, that the bars heel down. After the longitudinals are complete the shell can be hung.

No bolting whatever should be done, either on the centerline bulkhead or the shell, until the ship carpenters have shored one or more bulkheads accurately into place. If this is not observed, the work on the entire ship will "go bad." With a bulkhead set or "horned," this can be used as a starting point and the centerline bulkhead bolted to it first, then to the other transverse bulkheads, then its own seams and butts, then to the siffeners.

A similar procedure is carried out with the shell. The bracket connections are bolted last of all. In adjusting the shell, it is often necessary to throw away a few clips on the transverses. The bottom or side shell should not be bolted to the transverses until the transverses are bolted through the centerline. This is to prevent the transverse from sagging and pulling the centerline out of plumb.

The vertical webs on the transverse bulkheads can be shipped at any time, and there is great advantage in putting these webs in the cofferdams before the bulkheads are

bolted in the ship, as the webs will go in much easier if the bulkheads can be sprung apart.

Main Deck

We now come to the main deck. This being an oiltight deck, should have solid wooden molds made for it in the loft. It is preferable that the main deck should have no camber. The deck longitudinals should be dropped into the slots in the transverses, to be followed immediately by the deck plating. As this deck is only the width of the summer tank, it usually consists of three strakes, one of which is the stringer.

The middle strake should be lifted from the ship, and the deck should be bolted at once so this can go ahead, starting at the "horned" bulkhead. The deck stringer angle amidships should be put on, as well as the deck angle to the expansion trunk bulkhead, as these will aid greatly in regulating the deck. The rule is to bolt bulkheads first, then butt laps, then transverses. At the shell and expansion trunk the deck plating should be cut neat to the heel of the bars in way of bulkheads, although it may be cut slack between bulkheads.

A difficult point to make tight is the intersection of the main deck and expansion trunk bulkhead at transverse bulkheads. Various methods have been tried, such as flanging the deck plate up and lapping the expansion trunk plating on it, or extending the main deck plating inboard of the expansion trunk as a web, slotting the transverse bulkheads and stapling around the slot. The former is not very good, as it is hard to fit the bounding angle to the flanged plate. The latter method works fairly well. The inboard edge of the deck plate is flanged up for stiffness, the flange being cut away at the bulkheads, and at butt laps it can be drawn in slightly in the machine to save furnacing.

As soon as the deck is bolted, the ribband can be taken down and the shell hung in way of the deck, which will permit regulating it with the stringer angle to good advantage. The deck longitudinal brackets at the bulkheads should be put up and the longitudinals bolted, in order that the strake of deck plating can be lifted. Staying should be put in the tanks at the earliest possible moment, in order that the bolting can go ahead.

The transverses between main and upper decks inside the expansion trunk are the next members wanted. As soon as these are shipped, the expansion trunk stiffeners can be placed in their slots and the expansion trunk plating shipped. This plating, like the deck, should be cut neat in way of bulkheads.

After bolting this plating the transverses and bulkheads in the summer tanks can be put in the ship. These bulkheads divide the space into much longer compartments than the main tanks, with swash bulkheads between. The swash bulkheads should have an access manhole at a convenient height above the deck. The oiltight division bulkheads in the summer tanks should not have their bounding angles gotten out in the loft except those under the upper deck. The bounding bars to shell, main deck and expansion trunk should be lifted from the ship, and care should be taken that there is a space left open to get these bars in after lifting.

Upper Deck

We are now ready for the upper deck, which joins the top of the main tanks and the summer tanks. This deck has the usual camber. Most of what has been said regarding the main deck applies here as well. The strakes of deck plating directly over the centerline and expansion trunks should be lifted from the ship. Not more than two adjacent strakes should be gotten out in the loft. Oiltight deck plating should not be joggled; it is best to work the strakes clinker-fashion, with the clips on the transverses joggled, and tapered liners used in way of bulkheads.

The oiltight hatches are generally located on the upper deck, although in the shelter deck type there may be an oiltight trunk leading to the shelter deck, with the hatches on the shelter deck. There is a hatch for each tank, usually consisting of a small trunk, with a hinged cover and suitable dog clamps and asbestos gasket. In the cover is a cast steel or brass handhole and hinged cover, which is left open for air when filling or discharging, and also in order that the height of oil may be observed. The cover has a rest rod to hold it partially open.

In order to insure fairness of holes in the angle connecting the hatch to the deck, the deck flange of the angle should be left blank until the deck plating is assembled on the ship. Then before the hatches are shipped the deck holes can be lifted, applied on the hatch angle, and drilled off. Deck holes in the proximity of the hatch corners should be omitted, in order to prevent the possibility of their coming in the toe of the angle; if any such holes occur they should be driven flush before the hatches are shipped.

Hatches should not be located too close to the calking edge of deck plating. The vertical metal ladders in the main tanks should be put in place before the hatches are shipped.

In the bridge deck type the hatch covers are raised by means of a fall attached to the fore-and-aft bridge. In the shelter deck type, if the hatches are on the upper deck, it is necessary to provide a gas trunk around each group of hatches, and extending from the upper deck to the shelter deck, to prevent oil fumes from getting into the 'tweendeck. These gas trunks are apt to be a source of danger, as the oil vapor, which is heavier than air, will collect in them even when they are wide open at the top, and a man entering the trunk can very readily be overcome.

The trunks are watertight, and as they rest on the oiltight deck their bottom angles must be calked heel and toe, and the trunk plating should be cut slack for this purpose. Although it is somewhat risky, these angles should be gotten out in the mold loft, as they must be in place and riveted before tank-testing can begin. Ordinary practice would indicate lifting the bars after the decks and trunks are adjusted, but the delay would be too great. The trunks can be assembled on the ground and these bars bolted to them, but not riveted.

Over each trunk is an opening in the shelter deck, which is similar to an ordinary cargo hatch, with coamings, strong-backs, wood covers, etc. These hatches should be kept as small as possible, in order to maintain the strength of the shelter deck. In this case the oil hatch covers are raised by a fall attached to the coaming or strong-back above, but there is no provision for lifting the strong-backs themselves, as this is not likely to be necessary.

If the oil hatches are located on the shelter deck, a special oil trunk must be fitted in the 'tweendeck, and a special means of raising the hatch covers must be provided on deck. This system, while it enables a greater amount of oil to be carried, and does away with the gas trunks, is apt to cause an enormous head of oil in the tanks, which may be harmful.

Access to the cofferdams is obtained by means of small trunks with hinged hatch covers at the top, very similar to the oiltight hatches, but much smaller. Access to the pump room is provided through the pump room skylight,

which is a large bolted skylight located on the weather deck over the pump room hatch, and fitted with a watertight door.

Masts

Masts on a tank ship are unnecessary, except to carry lights, flags and wireless. If cargo booms are required for the hold forward of the oil space, a derrick post would be sufficient. No coaling gear is necessary, as this is furnished by the lighter or pier. So long as masts are used, however, they rest on the oiltight deck and must be provided for. A doubler is fitted on the deck, with an angle ring on it, to take the foot of the mast. The doubler is riveted to the deck, but the ring should be riveted to the doubler only, before it is put down. This is so that, if the mast works in the ring, it will not loosen any oiltight rivet. The deck rivets must be chipped flush, as well as the rivet heads under the ring, before the doubler is put down. If there is no shelter deck, the mast has no support other than its shrouds and stays. As the mast rests on the centerline bulkhead no additional foundation is necessary.

We have now covered the main structural features of the oilspace. The oiltight work requires minute care as to the fairness of holes, the tightness of bolting, the soundness of riveting, and the thoroughness of calking. Before bolting up a bulkhead, deck, or shell, it should be carefully regulated as a whole. No work should be reamed in the ship until all the adjacent members have been set and adjusted satisfactorily. Not only must the oiltight work attain a high degree of perfection, but all work in the oil space, even if not oiltight, involves important strength members and must be up to a high standard.

Packing

In regard to packing many specifications require that oiltight work must be metal to metal; but in the best practice a packing of canvas or lamp wicking soaked in red lead is freely used, especially in places not readily calked. For example, packing is generally used in laps of shell plating in way of bulkheads and under most clips located on the calking side of a bulkhead. The principal object to attain, however, is fair holes and work bolted up tight. "Dutchmen" and shim liners are very undesirable on work readily accessible. Packing may be omitted; for instance, on bilge keel bars it is not necessary to pack, provided the bars have the proper "set" to suit the curve of the bilge. The bilge keel bars should have the shell flange cut clear of the shell butts to facilitate calking, and in some cases the bars are also cut clear of the riveting through the transverses. When the shell flange is cut away, however, it should be done by chipping after the bars are in place; for if they are cut in the shop they will break in handling.

Fittings on an oil-tight deck, such as bitts, chocks, rail stanchions, fore-and-aft bridge supports, pipe brackets, etc., should be carefully packed and calked. A chock foundation, in this case, instead of having the usual flanged plate riveted in the bosom of the deck stringer angle, should have a clip riveted to the angle, and the plate riveted to the clip after the necessary calking has been done. Deck winches should not be located on the oiltight deck, if avoidable, and under no circumstances should a wood deck be fitted on an oiltight deck.

Tank Testing

Tank testing is a large item in the tank ship and should be started at the earliest possible moment, and all efforts should be directed toward that end, as it is highly desirable to do all testing on the stocks rather than overboard or in drydock; and if it is to be completed before launching, it must be out of the way in time to permit painting, fitting the cradle and taking down staging.

Every tank must be complete in every structural detail before water is put in. Usually, the aim is to test the tanks next the pump room first, in order that work in that space may go ahead. In general, the rule is to put water first in the tanks in which the calking sides of the bulkheads occur and test the shell, decks and expansion trunk; then, after dumping these tanks, the tanks in which the stiffeners occur are filled, and a final test is thus obtained of the calking sides of the bulkheads. This brings out the advantage of alternating the calking sides of the bulkheads. The tanks filled should balance each other, so that too much weight is not put on one side of the ship.

The ordinary tank testing on the stocks does not take in pipe fittings and many other fittings which are not installed until near completion. It is wise, therefore, to refill the tanks when the ship is completed in order to examine all pipe connections at bulkheads and decks, and all fittings such as pipe hangers, guards and brackets, operating rods, staunchions, clips, pads, etc., which may have been added since the original test.

(*To be concluded.*)

A Lumber Crane of Large Capacity to Be Installed on a Steamship Pier

The Seattle, Wash., Port Commission has recently awarded to the Shaw Electric Crane Company of Muskegon, Mich., a contract for a lumber-handling wharf crane, which will be larger than any crane previously installed for this class of service.

This crane is of the double cantilever type, with an overall length of a little over 200 feet, and the range of travel along the pier is approximately 800 feet. The end of the crane bridge projecting over the water is hinged to swing upward for purpose of clearance.

Lumber will be handled by a special grapple and in units containing 1,500 feet board measure. A standard hook may be substituted for the grapple, for handling structural steel and miscellaneous cargo. The openings through the gantry legs are wide enough to permit carrying material 32 feet long without interference. Means will be provided for transporting 9,000 feet of lumber on one of the gantry legs, in addition to the load carried by the grapple.

This installation is interesting, because it is a forward step in the handling of lumber by the unit system, and because it is the first municipal pier to be equipped with cargo cranes, indicating the progressive spirit of the Pacific Coast cities.

Adventures of the Nantucket

Beginning another chapter in her chequered career, the Merchants' and Miners' line steamer *Nantucket* has resumed service on the run between Boston and Baltimore, in command of Captain McDorman, late of the *Gloucester*, of the same company. She has just undergone extensive repairs at the Newport News shipyard, following her collision last January with the Old Dominion liner *Monroe*, which she sank off Hog Island, Va., with a loss of forty-four lives.

Renewal of a number of smashed bow plates, however, has not been wholly responsible for her losing the greater part of a year's work. After the tragedy she was tied up for months by litigation quite in keeping with the vicissitudes she has undergone of late.

Shortly before the *Monroe* affair she broke down off Cape Cod, southward bound, and was towed back to Bos-

ton by her sistership, the *Howard*. Just previously she had been run ashore in Vineyard Sound, with a heavy cargo of passengers and freight aboard, to avoid collision with a tow of barges. At this time, too, she sustained considerable damage, but it was small in comparison with that received in her preceding escapade.

While lying at her dock in Baltimore several months before, she caught fire, and for a time seemed doomed. Fire boats, however, pumped so much water into her that she capsized and for weeks lay on her beam ends alongside the wharf—a most unusual performance for a vessel of her size. Her salving by a wrecking concern was a notable feat.

So persistent has been the series of misfortunes which has pursued the *Nantucket* that she has been in commission only about half the time during the last three years. But in the opinion of seafaring men she is now amply entitled to a long and uninterupted period of prosperity.

The *Nantucket* is of 1,767 net tonnage and was built by Harlan & Hollingsworth, Wilmington, Del., in 1899.

Steamer Francis Hanify

The steamer *Francis Hanify,* illustrated on this page, is the seventh lumber steamer which the Harlan & Hollingsworth Corporation, of Wilmington, Del., has built for the Pacific Coast trade. She differs from the others principally in the subdivision of her cargo hold. Vessels in this trade usually go northward from San Francisco for a cargo of lumber, and in a light condition, which has proved to be unusually severe on them during the heavy northwesters which they encounter. It has, therefore, been found advisable to subdivide them much like an oil tanker, so that one or more compartments may be filled with water or oil to increase their draft and correct their trim, as the machinery is placed aft.

The principal dimensions of the vessel are as follows:

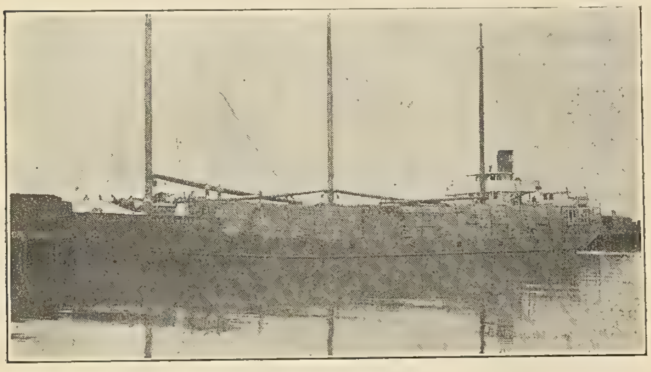


Fig. 1.—Lumber Steamer *John A. Hooper*

Length overall, 309 feet; length between perpendiculars, 294 feet; beam, molded, 45 feet; depth, molded, 21 feet 6 inches.

Hull

The hull is divided into the following compartments by transverse bulkheads: fore peak, Nos. 1, 2, 3 and 4 holds, cofferdam, machinery space, and after peak. As the holds are further subdivided by a longitudinal bulkhead and all riveted work is oiltight spacing, the eight compartments are suitable for carrying a liquid cargo, if required; each compartment is surmounted by a large cargo hatch having high coamings and oiltight portable steel covers, heavily framed to carry a deck load. A double bottom extends all fore and aft, 3 feet 6 inches deep. Oil fuel is carried in the double bottom and in fore peak tank, while settling tanks for fuel are built in the boiler room and extend to the upper deck. The double bottom abaft the cofferdam is used for carrying feed water and is increased in depth under the engine seat.

Although not classed in any registration society, the hull is strongly constructed. The double bottom has three longitudinals on each side of the centerline bulkhead, the framing being on the transverse principle with deep frames in lieu of webs. The frame and beam brackets are large and box beams are fitted at intervals. In line with the outer coaming of the hatches a box girder is worked above deck with intercostals between the beams and a continuous member below the beams, bracketed to the bulkheads. The shell plating at the forward end has additional strength in the shape of treble riveted seams and closer spaced frames to resist sheering and panting stresses when pitching in head seas.

The vessel has a closed topgallant forecastle, an open bridge, and a closed poop. The doors in the forecastle bulkhead and in the house around the machinery are all watertight.

Accommodations

As will be seen on the plans, the deckhands are housed in the forecastle and have a stairway with a companion

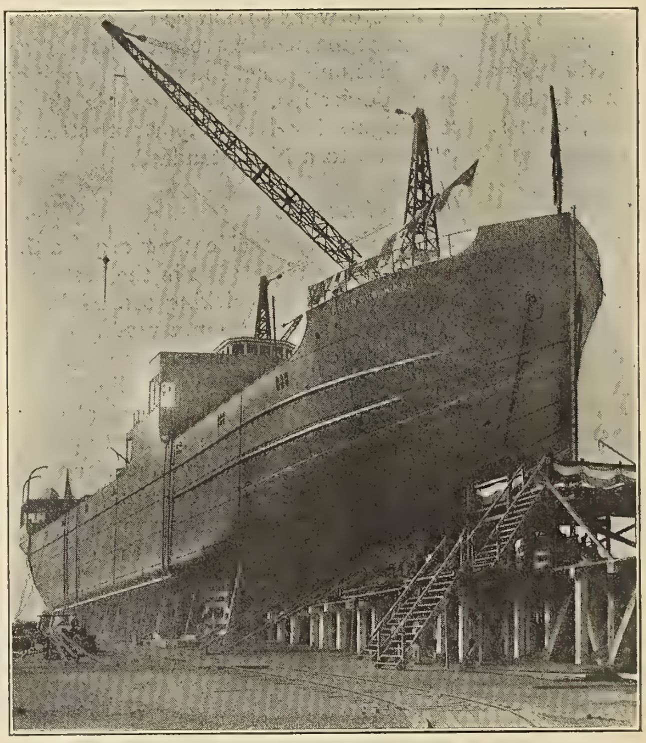


Fig. 2.—Steamer *Francis Hanify* Ready for Launching

on the forecastle head for access when the vessel is carrying a deck load. The deck officers' quarters are in a house on the bridge deck, the pilot house and chart room being above same. The galley, storerooms, cook's, oilers' and firemen's quarters are located in the poop, while the engineers' quarters and dining saloon are in a house on the poop deck. The officers' and crew's quarters are conveniently located and ample provision has been made for their comfort, showers being fitted in all toilets.

Rig and Cargo Handling

The vessel has three steel pole masts and carries sail on the fore and main masts. Each hold is served by two derricks, each 70 feet long, the vangs for the derricks being carried to the head of the mast opposite, while one

set of vangs has its standing and belaying parts on deck. This arrangement allows a clear space for swinging the lumber while loading or unloading.

The winches, made by Murray Brothers, San Francisco, are of the double drum type, to which the cargo falls are attached, the niggerheads being used for topping lifts, etc. The winches are operated by one man, who stands with the winch at his back, and, being located on a high platform, he obtains a view of his lift during its transit from the vessel's hold to the dock or barge alongside, and

CARGO

The hold and hatches are arranged so that the vessel may carry a lumber cargo, general cargo, or a liquid cargo. An 8-inch main suction pipe, having 6-inch branches into each compartment, is provided, with a suitable cargo pump in the engine room. Provision is made for lumber deck loads as follows: The ends of the forecastle, poop, and sides of the house around the boiler casings are efficiently stiffened on the outside. The bridge deck is 12 feet high, having open ends. The winches are

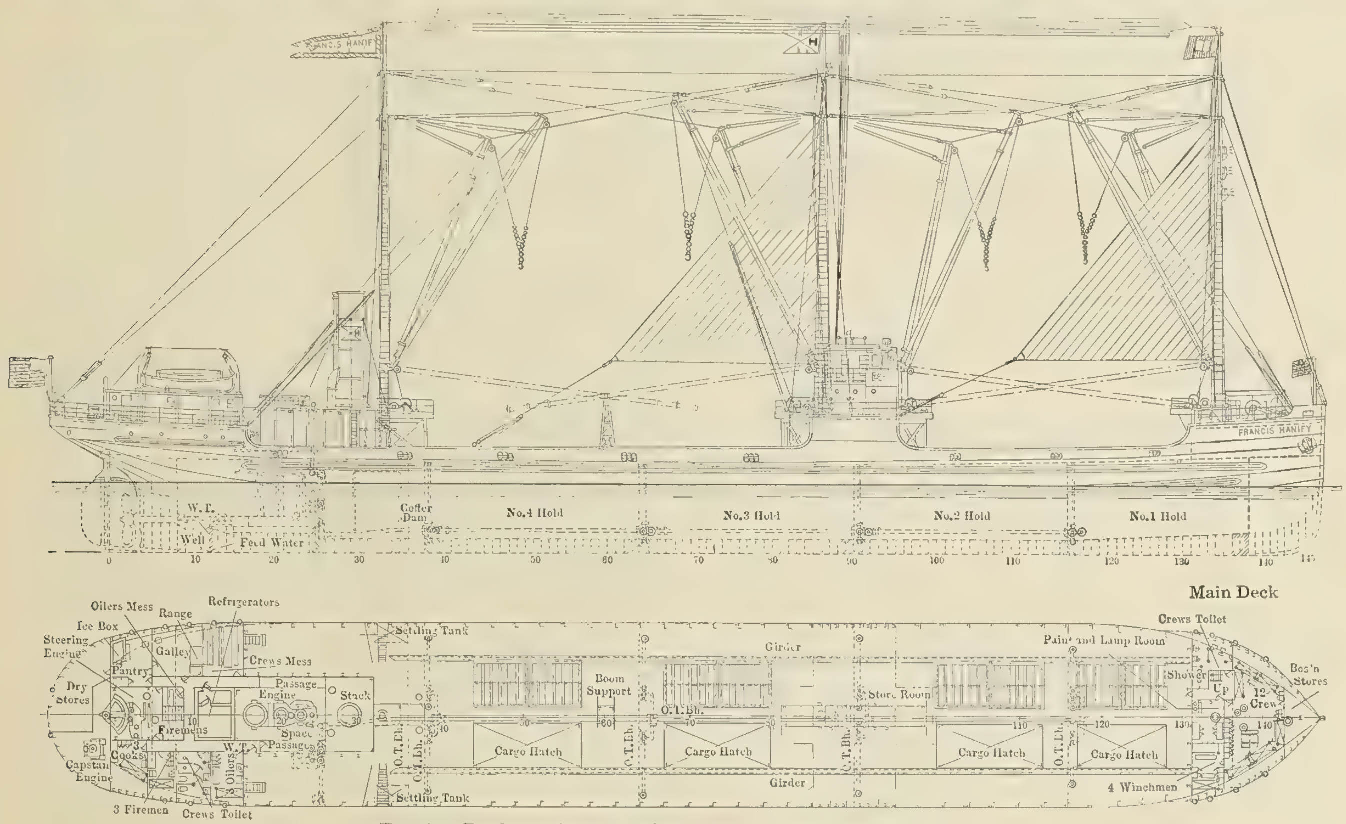


Fig. 3.—Profile and Plan of Main Deck of the *Francis Hanify*

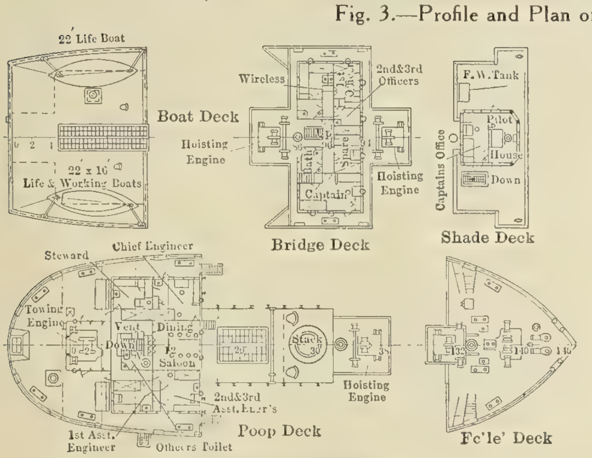


Fig. 4.—Deck Plans

is above the cargo even when the vessel has a deck load on board.

A heavy towing machine, of American Engineering Company's make, is located in the deck house on the poop, with an adjustable towing chock at the rail aft. A warping capstan is placed on the poop, and the steering gear under the poop, the steam gear and the hand gear of which engage directly with the interchangeable tooth rack of the quadrant. The windlass on the forecastle head has large warping ends. The three latter auxiliaries are of the Hyde make.

placed on platforms 13 feet high, while the bulwarks are efficiently braced. A sampson post is built in the after well to steady lumber, and serves as rest for derricks, heavy chain lashings are fastened to chain plates secured to the sheerstrake about 12 feet apart for the length of the open deck and meet over the top of the deck load, drawn tight by rigging screws and provided with chain slips so that in case of necessity they may readily let go.

The vessel is lighted by electricity and has a searchlight fitted on top of the pilot house, but controlled from within. The vessel is also equipped with wireless telegraph, life saving, and all other outfits required by the Rules and Regulations prescribed by the United States Board of Supervising Inspectors.

The *Francis Hanify* can carry 3,500 tons deadweight on a draft of 17 feet 6 inches, and when carrying a deck load the deadweight may run well over 4,000 tons. Fig. 1 shows the steamer *John A. Hooper*,* a similar ship built by the Harlan & Hollingsworth Corporation, when carrying a deck load, the total lumber on board being 2,100,000 square feet taken at an average thickness of one inch. This vessel is 10 feet shorter than the new steamer, and has averaged 12 knots in a loaded condition on a long sea voyage, the average fuel consumption being 7½ barrels of oil per hour. The *Francis Hanify* is expected

* Described on page 72, INTERNATIONAL MARINE ENGINEERING, February, 1913.

to make 11½ knots under similar conditions with the same machinery.

Machinery

The propelling machinery consists of one triple expansion, surface condensing engine having cylinders 21 inches, 34 inches, 56 inches diameter by 42-inch stroke, designed to develop about 1,800 indicated horsepower at 98 R. P. M. The high and intermediate pressure cylinders have piston valves, and the low-pressure cylinder a double ported slide valve, all worked by Stephenson type link motion. Reversing is accomplished by a direct-acting steam cylinder, automatically operated. The condenser is cylindrical in shape, mounted independent of the main engine, the condensing water being supplied by a centrifugal pump worked by a single cylinder engine. The air and two bilge pumps are of the ordinary single-acting type worked from the crosshead of the high-pressure cylinder.

The shafting is of forged open hearth steel, the crank shaft 11½ inches diameter in three interchangeable sections. The thrust shaft has six rings working against a thrust bearing of the horseshoe type.

The propeller is a solid, four-bladed, cast steel wheel, 14 feet 6 inches diameter.

There are two vertical duplex feed pumps 8 inches and 5 inches diameter by 18-inch stroke, which pump the water from the filter tank and discharge it through a feed water heater of the multicoil type to the boilers. There are also independent pumps of the horizontal duplex type, one for the fire alarm system and bilges, one for the wash deck system and bilges, one for the salt water sanitary system, and one for the fresh water system.

The centrifufal pump and the air and bilge pumps were made by Harlan & Hollingsworth, while all other pumps were made by the Warren Steam Pump Company.

Steam is supplied at a working pressure of 180 pounds per square inch by two three-furnace boilers of the cylindrical return tube type, each 14 feet 3 inches diameter and 11 feet 9 inches long. The boilers are arranged for burning crude oil as fuel, the high-pressure or mechanical system being used, the atomizing being done without air or steam. The burners are of the Union Iron Works make. The heating surface in the boilers is 5,000 square feet.

The oil fuel system is very complete, having a special pump for pumping the oil from the double bottom into settling tanks, whence it is pumped through strainers and heaters arranged in duplicate to the burners. Special valves operated from the deck are provided inside the settling tanks for shutting off oil in case of leaks in the fireroom, and the supply of oil to the burners can also be regulated from the deck.

Other auxiliary machinery in the engine room consists of one large cargo oil pump, one one-ton ice-making plant, two electric generating sets, one 12-ton evaporator, distiller, etc. The ice machine was supplied by the Remington Machine Company, the feed water heater, evaporator and distiller by the Griscom-Russell Company, and the generating sets and searchlight by the General Electric Company.

Resolution Adopted by the Institution of Naval Architects.—At a special general meeting of the Institution of Naval Architects, held on December 8, a resolution was passed providing that all subjects of the foreign countries with which Great Britain is now at war (viz., Germany, Austria-Hungary and Turkey) are suspended from exercising the rights and privileges of membership in the Institution during the continuance of hostilities and until reinstated by special resolution of the Council.

The U. S. Collier Jason as a Christmas Ship

The U. S. collier *Jason,* offered by the United States Government to carry to Europe the Christmas presents given by the various organizations in the United States to the orphans of the countries at war, sailed from New York on November 4, 1914, after having taken on board its package cargo by means of the "marine transfers," with which the vessel is equipped for the rapid handling of coal. This event was noteworthy from an engineering standpoint on account of the fact that one man, with a lever in each hand, hoisted loads at the rate of 400 or 500 feet per minute from the dock, swung them easily over the hatch and dropped them wherever wanted in the hold.

In contrast to this one-man performance, two or three men usually perform the same functions handling package cargo with other methods, in which hoisting speeds of 350 to 400 feet per minute are rarely attained, and then only

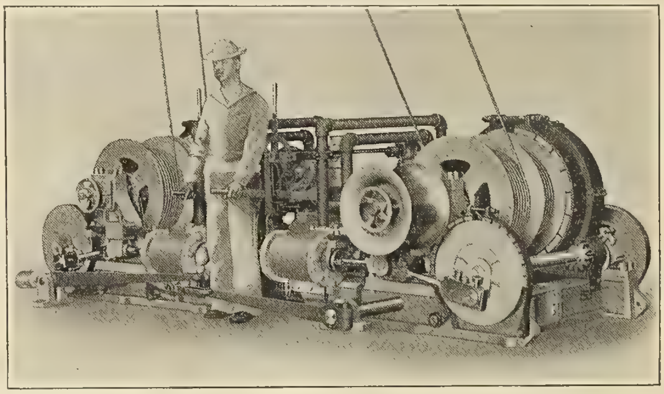


Fig. 1.—Hoisting Winches Controlled by One Man

under favorable conditions. With the "marine transfer" the maximum speed is always utilized because the loads are hoisted or lowered at the center of the hatch or away from the side of the ship, and hence free from all obstructions.

The "marine transfer" permits loads to be landed at several points in the hatch, thus allowing the employment of two or three gangs under each hatch. The stevedores in charge of the loading of the *Jason* were enthusiastic about the system, particularly because the load could be delivered wherever wanted.

The Marine Transfer

As installed on the *Jason,* the "marine transfer" consists of a series of "A" frame towers, one "A" frame being located between each pair of hatches. The tops of these "A" frames are connected by a girder running fore and aft. On this girder and directly over the center of each hatch is a block through which the fall rope passes. Reaching out on both sides of the vessel are booms, two for each hatch, the outer ends of each pair of booms being in line with the center of the hatch fore and aft. Connecting the outer ends of these two booms are two ropes, each attached to opposite ends of a trolley or swinging block. These two ropes pass around pulleys on the end of the booms and are then led to the drum of the swinging winch. The load fall drops from the overhead block and passes through the trolley or swinging block, terminating in a cargo hook for attaching the load.

The position at which the load is taken or delivered is controlled by the position athwartship of this trolley or swinging block. The hoisting and lowering of the load is

controlled by one winch operated by a single lever, whereas the swinging block is controlled by a second winch, also operated by a single lever. In a very short time any seaman or stevedore can operate these winches. The load can be taken or deposited at any place from the tip of one outstretched boom to the tip of the other boom. With a little experience, both hoisting and swinging may be carried on simultaneously, thus making the shortest path for the load and the shortest operating cycle.

A ship of the *Jason* type as a freighter for regular package cargo would probably be the fastest ship in the world as regards cargo handling. This statement is borne out by the record made by the *Jason* when coaling the U. S. battleship *Wyoming* in Guantanamo Bay in the spring of 1914.

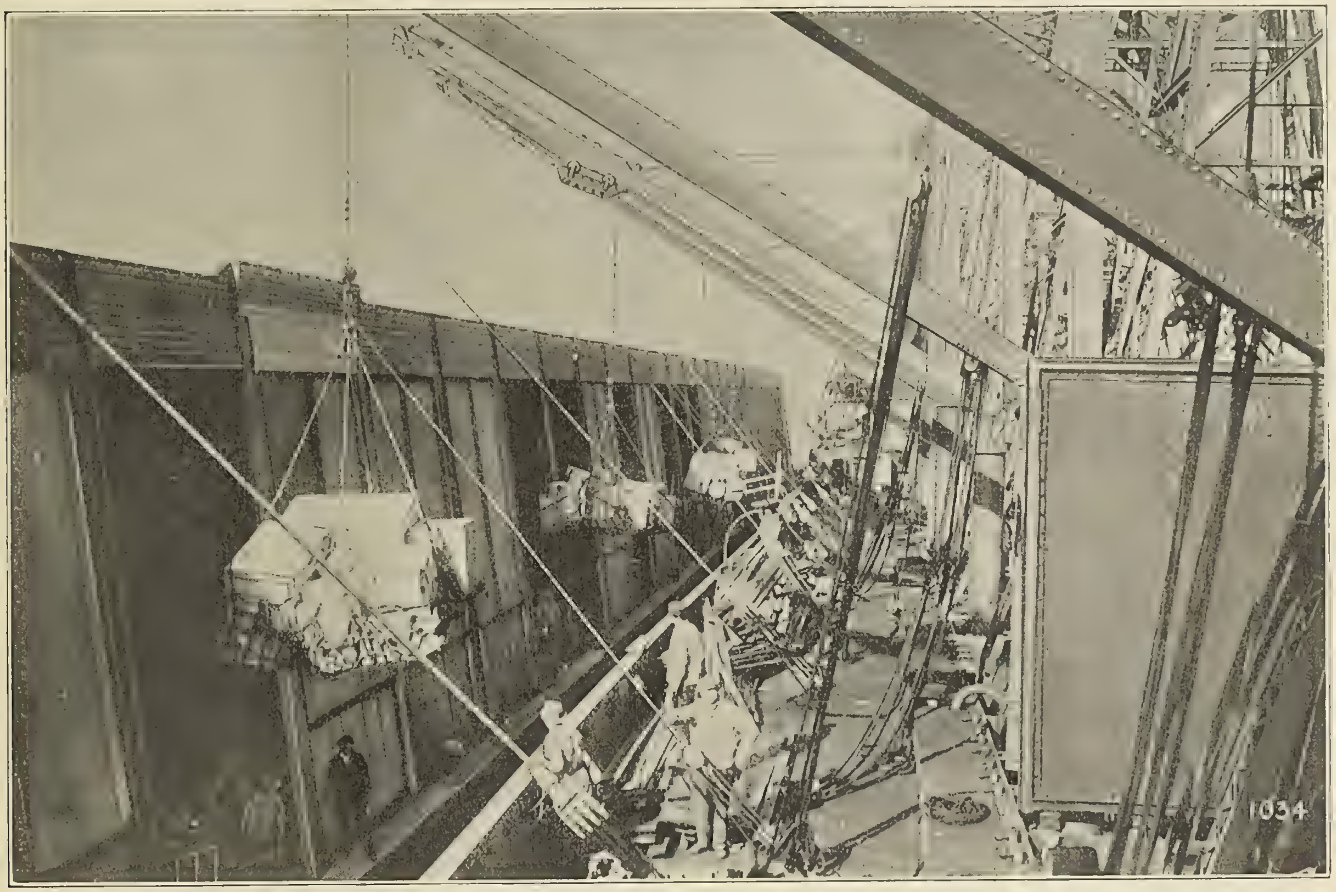


Fig. 2.—The "Marine Transfers" on the *Jason*, Loading the Ship with its Christmas Freight

COALING THE WYOMING

The *Wyoming* was coaled from two naval colliers, the *Jason* and the *Nereus*, both of which are equipped with the most recent types of coal-discharging apparatus. The *Jason* is equipped with twelve "marine transfers," each operated by one winchman. The *Nereus* is equipped with twelve special cableways, each operated by two winchmen. Both discharge with clamshell buckets.

The *Jason* was on one side of the *Wyoming* and the *Nereus* on the other. Both colliers rigged out eight booms over the deck of the *Wyoming*. The *Jason* used her eight booms continuously, dropping coal at eight different points along the deck and through the chutes of the *Wyoming*, while the *Nereus* used six to eight booms, intermittently, on account of breakages.

All was made ready for test the night before—time to get ready not given (usually 20 to 30 minutes' work on the *Jason*). Coaling began at 5.30 in the morning. Coaling stopped at 8 o'clock for breakfast. Coaling resumed at 8.30. The *Jason* cast off at 9 o'clock. The *Nereus* cast off at 9.30 o'clock. The *Jason* delivered to the *Wyoming* a maximum of 465 tons per hour. The *Nereus* delivered to the *Wyoming* a maximum of 433 tons per hour. The *Jason* delivered a total of 1,040 tons in three working hours, an average of 346 tons per hour. The *Nereus* delivered a total of 1,020 tons in three and a half working hours, an average of 292 tons per hour.

From 550 to 600 tons of coal were heaped on board when the colliers left, and it required from 9 o'clock in the morning to 4.30 in the afternoon to clear up and stow the coal left on board. The whole operation of taking on and stowing 2,060 tons of coal was accomplished in nine and a half hours, an average of 217 tons per hour.

Both the *Jason* and the *Nereus* coaling gears are able easily to discharge 100 tons of coal per hatch per hour. In the official trial of the collier *Jason* 137½ tons of coal were actually discharged in one hour with one operator.

At the conclusion of the trial Admiral Badger expressed the opinion that the *Wyoming* could at any time take on 2,100 tons of coal in five hours from two colliers in smooth waters, stowing the surplus left on deck at leisure.

From the above it appears that from one collier the taking on and stowing of 2,100 tons of coal would require approximately ten hours, being an average of 210 tons per hour.

MONTHLY SHIPBUILDING REPORT.—During the month of November 71 vessels of 14,564 gross tons were built and officially numbered in the United States. Four of these, aggregating 8,637 gross tons, were steel steamships. From other sources than construction 10 vessels of 31,221 gross tons were added to the American merchant marine in accordance with the Act of August 18, 1914.

Shipbuilding in the United States in 1914

**Total Output Less than the Tonnage Produced a Year Ago—
Largest Output from the Fore River Shipbuilding Corporation**

In general, the amount of tonnage turned out by the leading shipbuilders in the United States in the year 1914 was considerably less than that produced in the previous year. The principal exceptions to this, however, were on the Great Lakes, where the Great Lakes Engineering Works produced double the tonnage of last year, and, on the Pacific Coast, where the Union Iron Works completed nearly four times the tonnage of merchant vessels which they produced in 1913.

As shown in Table I, which gives the number, gross tonnage and indicated horsepower of the output from twelve of the leading shipyards in the country, the greatest amount of merchant tonnage was produced by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va. From Table II, which shows the number, displacement and indicated horsepower of naval vessels completed during the year by five of the leading shipyards in the country, the greatest amount of naval construction was completed at the Fore River Shipbuilding Corporation, Quincy, Mass. Combining the merchant and naval tonnage produced by any one yard, it will be found that the Fore River Shipbuilding Corporation stands at the head of the list, with the New York Shipbuilding Company second.

Output of the Atlantic Coast Yards

The largest vessel completed at the Fore River yard was the battleship *Nevada*, of 27,500 tons displacement and 26,500 indicated horsepower. The propelling machinery of this vessel consists of Curtis turbines. The other naval work included a destroyer, also fitted with Curtis turbines; the submarine tender *Fulton* and two submarines, both the submarine tender and the submarines being fitted with Diesel engines supplied by the New London Ship & Engine Company, Groton, Conn. The engine for the *Fulton* was of about 1,000 horsepower and is the largest single Diesel engine so far installed in an American ship. The merchant work turned out by the Fore River yard consisted of the freight steamers *Atlantic* and *Pacific*, which have already been described in these columns. The work now in hand at this yard consists solely of naval work, and includes one destroyer and eight submarines.

TABLE I.—MERCHANT CONSTRUCTION

	No.	Gross Tons.	I. H. P.
Newport News Shipbuilding and Dry Dock Company	5	31,987	15,500
Maryland Steel Company	9	25,045	12,690
New York Shipbuilding Company	8	20,809	9,500
American Shipbuilding Company	4	19,857	6,084
Great Lakes Engineering Works	9	19,598	7,375
Union Iron Works	3	14,072	5,200
Fore River Shipbuilding Corporation	2	11,196	4,200
American Car & Foundry Company	16	10,451	......
Harlan & Hollingsworth Corporation	5	5,524	4,540
W. & A. Fletcher Company	2	2,806	3,200
Detroit Shipbuilding Company	1	2,072	1,000
Johnston Bros.	5	1,071	580

TABLE II.—NAVAL CONSTRUCTION

	No.	Tons Displacement.	I. H. P.
Fore River Shipbuilding Corporation	5	30,998	46,300
Wm. Cramp & Sons' Ship & Engine Building Company	4	4,037	33,950
New York Shipbuilding Company	1	2,600	9,000
Seattle Construction & Dry Dock Co.	4	2,146	3,350
Bath Iron Works	1	1,010	16,000

The merchant tonnage of the Newport News Shipbuilding & Dry Dock Co., which was the largest total from any yard for the year, included the bulk oil freight steamers *John D. Archbold* and *John D. Rockefeller*, the Mallory freight steamships *Neches* and *Medina* and the collier *Edward Pierce*. The only other work completed during the year consisted of barges and dump scows. The work now on hand, however, includes the battleships *Pennsylvania* and *Mississippi* and the two revenue cutters described elsewhere in this issue.

At the Maryland Steel Company, Sparrows Point, Md., the last three of the American-Hawaiian Steamship Company's freight steamers, the *Washingtonian, Iowan, Ohioian*, of 6,649 gross tons each, were completed during the year, and also four steel dump barges for Panama Canal service, of 1,000 gross tons each, and two steel lighters for the Pennsylvania Railroad. In addition to the ships constructed, three large Scotch boilers were delivered for installation on towboats. There are now under construction at the Maryland Steel Company's yard two colliers for the Panama Canal, of 10,650 gross tons and 7,200 indicated horsepower each.

Although naval construction comprises the bulk of the work now in hand at the New York Shipbuilding Company, Camden, N. J., none of it was completed during the year. There were delivered, however, two large oil steamers of 5,188 gross tons and 2,650 indicated horsepower each for the Gulf Refining Company; the collier *Hampden*, of 4,725 gross tons and 2,100 indicated horsepower, for the Coastwise Steamship Company; the municipal ferry *Mayor Gaynor*, of 1,634 gross tons, for New York City, and four car floats for railway service. The output also included a protected cruiser of 2,600 tons displacement, fitted with Thornycroft boilers and Parsons turbines, for the Greek government. The work now in hand includes the Argentine battleship *Moreno*, of 27,630 tons and 49,300 horsepower, equipped with Curtis turbines; the United States battleships *Oklahoma*, of 27,500 tons and 26,240 indicated horsepower, and the *Idaho*, of 32,000 tons and 37,000 horsepower. The former is propelled by reciprocating engines and the latter by Parsons turbines. There are also four destroyers and the destroyer tender *Melville*. Two large merchant vessels are also under construction, one of which is an oil tanker for the Gulf Refining Company, which is a duplicate of the two delivered during the past year; and the lumber steamer *William O'Brien*, of 5,528 gross tons and 2,000 horsepower.

During the last two years the output from the Jackson & Sharp plant of the American Car & Foundry Company, at Wilmington, Del., has been noteworthy on account of the large tonnage of wooden vessels built. This year the total output amounted to 10,451 tons, which is considerably in excess of the output from any other wooden shipyard in the United States. The tonnage consisted principally of seagoing barges, car ferries and dump scows. At present there is under construction 2,375 tons of dump scows.

The vessels built by the Harlan & Hollingsworth Corporation, Wilmington, Del., included the coastwise oil or lumber steamer *Francis Hanify*, of 2,588 gross tons and 1,720 indicated horsepower, described elsewhere in this issue; the side-wheel excursion boat *Hanover*, for the Louisiana Steamboat & Ferry Company; the double-screw ferryboats *Delaware* and *Weehawken*, the former for the Delaware River Ferry Company of New Jersey, and the latter for the New York Central & Hudson River Railroad Company. This company also built the floating crane

elevator *Commonwealth* for Philadelphia Harbor Transfer Service, and supplied the machinery for two small wooden steamers, the hulls for which were built elsewhere, and the machinery for a seagoing tug. Marine boilers amounting to 1,000 horsepower were also built for outside purposes.

All of the work completed by William Cramp & Sons' Ship & Engine Building Company, Philadelphia, Pa., consisted of naval vessels, including one submarine, two destroyers and the gunboat *Sacramento*. The work now under construction includes the two turbine passenger ships *Great Northern* and *Northern Pacific*, of 8,255 gross tons and 25,000 horsepower each, described in our December, 1914, issue; the car ferry *Henry M. Flagler*, for the Florida East Coast Railway, and five destroyers for the United States Navy. All of these vessels, either built or building, with the exception of the car ferry, are equipped with either White-Foster or Babcock & Wilcox watertube boilers.

The W. & A. Fletcher Company, Hoboken, N. J., completed during the year two ferry boats for the New York Central & Hudson River Railroad. These vessels were sister ships of 1,403 gross tons and 1,600 horsepower each. At the Bath Iron Works one United States destroyer and the racing yacht *Defiance*, for the Tri-City Syndicate, were completed, while one other destroyer is now under construction The output of the Staten Island Shipbuilding Company, Port Richmond, New York, for the year, which amounted to 702 gross tons, consisted of three tugs. This company now has in hand four other tugs aggregating 1,380 gross tons.

In Baltimore, the Skinner Shipbuilding & Dry Dock Company completed two tugs, and the Spedden Shipbuilding Company, a steel fire-boat for the city of Baltimore. The former company has in hand a self-propelled seagoing suction hopper dredge of about 500 gross tons for the United States Army Engineers, and the latter company, a steel screw lighthouse vessel and a steel dredge for the United States Army Engineers.

Other work completed during the year consisted of a tug-boat built by the Lake Torpedo Boat Company, Bridgeport, Conn.; two barges by the Johnson Iron Works, Incorporated, New Orleans, La.; five dump scows and a dredge hull by John H. Mathis & Co., Camden, N. J.; and a 90-foot derrick lighter built by the Thames Towboat Company, New London, Conn.

Shipbuilding on the Great Lakes

Both the American Shipbuilding Company and the Great Lakes Enginering Works, Detroit, Mich., produced about 20,000 tons of shipping during 1914. The vessels built by the American Shipbuilding Company included the bulk freighter *Howard M. Hannah, Jr.*, of 6,204 gross tons and 1,760 horsepower, built at Cleveland; the bulk freighter *Robert L. Ireland*, of 6,387 gross tons and 1,600 horsepower; the bulk freighter *William D. Crawford*, of 6,385 gross tons and 1,800 horsepower, and the sand sucker steamer *Kelley Island*, of 881 gross tons and 924 indicated horsepower, all built at Lorain. The output of the Great Lakes Engineering Works included the passenger steamer *South American*, of 2,662 gross tons and 2,500 horsepower, for the Chicago, Duluth & Georgian Bay Transit Company; a bulk freighter of 6,311 gross tons and 1,800 horsepower; a lumber steamer of 1,815 gross tons and 700 horsepower, and a special type of self-unloading freighter, the *Huron*, of 4,810 gross tons and 1,775 horsepower, for the Wyandotte Transportation Company. The company also completed four producer-gas coal barges of 1,000 tons capacity each for the Alabama & New Orleans Transportation Company.

While a number of other vessels were built on the Great Lakes, their tonnage for the most part was small. One of the largest was a freighter of 2,072 gross tons and 1,000 horsepower built by the Detroit Shipbuilding Company, Detroit, Mich., for the George Hall Coal Company. Johnston Bros., of Ferrisburg, Mich., built a small passenger vessel equipped with an oil engine of the semi-Diesel type, as well as two tugs and two electric dredges for the Yuba Construction Company. The Manitowoc Shipbuiilding & Dry Dock Company also built two tugs, a hydraulic dredge and a dipper dredge. Two ice-breaking tugs fitted with Kingsford boilers and high-pressure engines were built by the Cowles Shipyard Company, Buffalo, N. Y., and this company now has in hand a ferry tug of 150 horsepower for the Tonawanda & Grand Island Ferry Company.

Work in the Pacific Coast Yards

The largest output on the Pacific Coast was by the Union Iron Works, San Francisco, Cal., where two large oil tankers, the *Frank H. Buck* and *Lyman Stewart*, both of 6,076 gross tons and 2,600 horsepower, were delivered, the former to the Associated Oil Company and the latter to the Union Oil Company. A 116-foot oil barge with a capacity of 2,060 barrels was also built for the Standard Oil Company. Three submarines were completed for the United States Navy, and a large caisson, 113 feet 10 inches long by 36 feet beam by 65 feet depth, was built for the Isthmian Canal Commission. The Union Iron Works now has under construction for the Standard Oil Company an oil tank steamer of 6,000 gross tons and 2,600 horsepower.

At the yards of the Seattle Construction & Dry Dock Company, Seattle, Wash., all of the work built or building was for the United States Government. Three Government tug boats of 250 gross tons and 800 horsepower were completed, and also one submarine. The only vessel now under construction at this yard is the submarine tender *Bushnell*, of 2,500 gross tons and 2,500 horsepower. This vessel is to be fitted with Yarrow watertube boilers and geared turbines.

Two vessels, one a steel lumber and oil steamer of 1,319 gross tons and 1,000 horsepower, and the other a steel suction dredge with the hull 140 feet long, were built by the Craig Shipbuilding Company, Long Beach, Cal., where there are now under construction two submarines of the Lake type fitted with Busch-Sulzer Diesel engines.

Shipbuilding in the Navy Yards

A greater amount of shipbuilding work is now in progress in the Government navy yards than ever before in the history of the new Navy. During 1914 the Secretary of the Navy authorized new construction work at three navy yards which hitherto have not undertaken the construction of vessels. Formerly ship construction was carried out only at the New York Navy Yard, Brooklyn, N. Y., and at the Mare Island Navy Yard, San Francisco, Cal., but now, in addition to the battleships *Arizona* and *California*, which are being built at the New York Navy Yard, and the fuel ships *Kanawha* and *Maumee*, building at Mare Island Yard, work has begun on the construction of a submarine at the Portsmouth Navy Yard, Portsmouth, N. H., on the supply ship *No.* 1, at the Boston Navy Yard, and on the transport *No.* 1, at the League Island Navy Yard, Philadelphia, Pa. Construction on these vessels, however, was delayed for over a year on account of the necessity for installing new machinery and equipment before the work was begun.

One Hundred Percent Efficient, Yet Obsolete

That the only merchant sailing-vessel rig known to this continent which presents the acme of efficiency in operation should become extinct is passing strange; yet in the 60-ton centerboard New Brunswick schooner *Gold Finder* is seen one of the last survivors of such a vanishing type.

The *Gold Finder's* rig consists of two pole masts, fore and main sails and no bowsprit. Under no conditions can any portion of her sail area be blanketed by another part. With the wind from any quarter her entire spread of canvas is bound to draw. All her sails can be furled from the deck and going aloft is unnecessary. The men can easily navigate her.

Her hull, too, is the height of simplicity in naval architecture. She is apple-bowed and box-sterned, with no overhang at either end to speak of. Her rudder is hung "out-of-doors," as on an overgrown rowboat. Well along in years, and built of inexpensive spruce, to-day $400 (£82) is a conservative estimate of the *Gold Finder's* worth; yet she is capable of carrying an 80,000-foot cargo of lumber from New Brunswick to Boston in a week, and getting $3.50 (14s. 7d.) per thousand for her trouble much of it obviously would be clear profit.

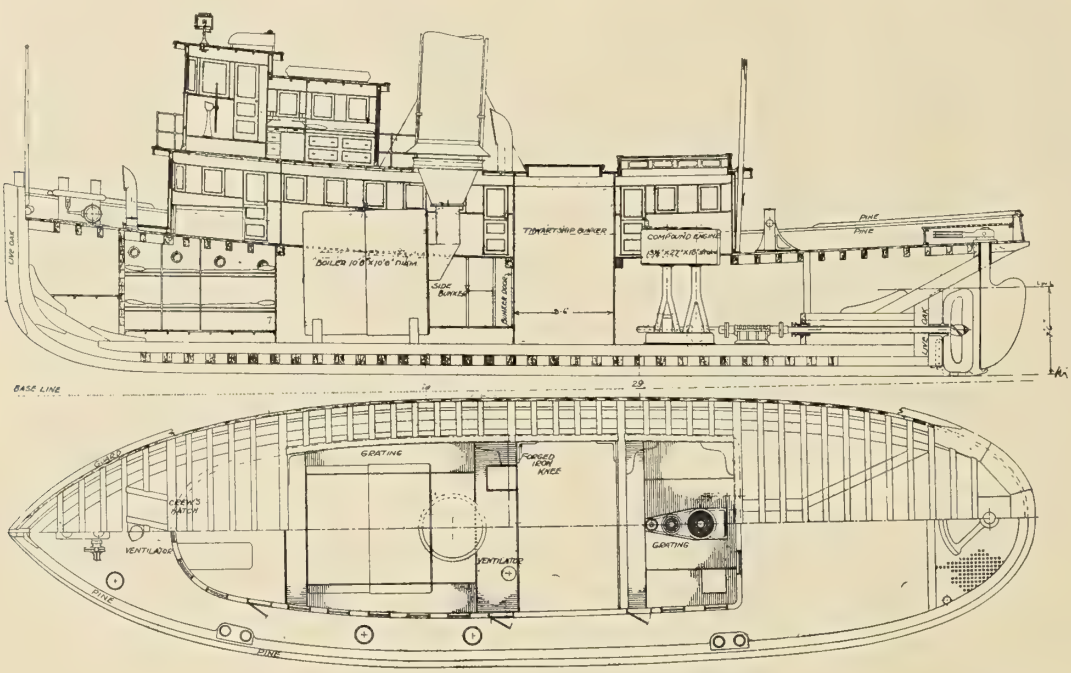
The *Gold Finder* is one of the original St. John woodboats, which used to be seen on the New England coast in hordes, and which tradition says came west out of the fog and gloom of the Bay of Fundy, with muskrats perched on the rudder heads! Formerly these craft were given "bald-headed" rigs, in order to obviate housing topmasts when passing under bridges on the St. John river, but in later days the Provincial coasters have become Americanized to the extent of adopting headgear, topmasts and stern overhangs.

At present the *Gold Finder* is one of a small fleet of down-easters engaged in carrying cord-wood from Beaver Harbor, N. B., for consumption in the lime kilns at Rockland and Rockport, Me. She is, however, one of the last of this type of vessel and her days of usefulness are probably about over. She will undoubtedly be superseded by motor craft.

Shallow Draft Wood-Burning Tug

The illustration shows an 87-foot tug now being built from plans by J. Murray Watts, of Philadelphia, for the Poitevent & Favre Lumber Company, of Mandeville, La. This design is interesting, as it shows a tug adapted to the local conditions, which require a boat of good power and seaworthiness for use along the Gulf of Mexico, and at the same time the draft is limited to 7 feet 6 inches on account of some of the tows calling for navigation of inland waterways. To get this shoal draft, very good beam is required and 22 feet for the molded beam was found to be satisfactory.

The question of fuel came up, and it was found that wood fuel was about one-half the cost of coal. Therefore it was decided to use wood, and for this reason the bunkers are unusually large, there being an athwartship bunker 8 feet 6 inches long in a fore and aft direction which allows two lengths of 4-foot wood to be piled therein. Besides this, the regular side bunkers are fitted as usual and the wood in these is carried as a reserve.



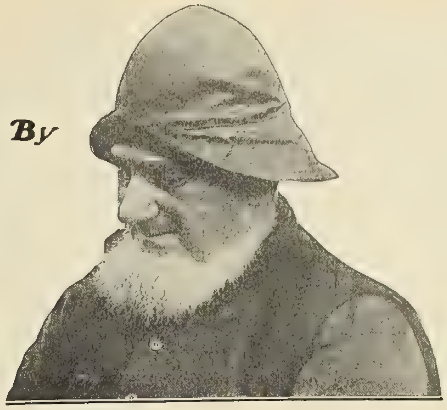
General Arrangement Plan of 87-foot Tug

The machinery equipment consists of a Scotch boiler with two furnaces adapted for burning wood, the diameter of the boiler being 10 feet 6 inches and the length 10 feet 8 inches. The engine is a fore and aft compound, 13½ inches and 27 inches by 18 inches stroke, developing 300 horsepower. There is a complete electric lighting plant with a 5 kilowatt turbine-driven generator, giving sufficient current for the incandescent lamps and a 14-inch arc searchlight.

The Poitevent & Favre Lumber Company furnished all the lumber for the hull, and naturally this is of the finest quality; the stem, keel and sternpost being of live oak, the frames being 5-inch by 10-inch double, spaced 22 inches, and the planking varying from 3½-inch to 2½-inch cypress.

Trial Trip of the Great Northern.—The new Pacific coastwise liner *Great Northern*, which was described in our last issue, underwent her official trials recently over the Rockland course, attaining a speed of 24.7 knots, or 1.7 knots in excess of her designed speed.

Economy Talks By "Old Scotch"



Economical Use of Electricity for Lighting

There are ways to save money on shipboard other than those connected with the making of the steam. The economical using of it is quite as important, but in this connection the savings are smaller and they come from attention to small details. But, as my Scotch friend says, "Many a mickle makes a muckle," so it is well for us marine engineers in these piping hard times to watch the spigot as well as the bunghole.

Since the days of the scriptural injunction, "Let there be light," mankind has found it quite a task to furnish artificial light to carry on the work when natural sources of light are cut off. On the modern steamship lighting has reached such a stage that all parts of the machinery spaces are very easily made almost as light as day. When I first went to sea we had to put up with old, smoky kerosene (paraffin) bulkhead lamps and petticoat lamps burning the extract of hog fat. These lights would generally go out at the most critical times, and they were a darned nuisance at all times. Nowadays almost any old steam packet, from a harbor tug up, is furnished with a dynamo, and the lighting question is easy; in fact, it is so very easy that I am afraid that many of us overlook the fact that it costs money to keep the light burning. True, we do not have to buy any lamp oil or wicks, but do not forget that we are using up steam, steam means coal, and coal means money and lots of it at times. I went aboard a 2,500-ton coasting steamer to see an old friend of mine recently, and the first thing that struck me was that carbon lamps were being used all over the ship.

Now in these days the use of carbon lamps is simply a crime perpetrated on the coal pile, and there is no excuse for it. When these new-fangled Tungsten or Mazda lamps, or whatever else they call them, first came out, I looked on them a little bit shy, as they cost like the dickens and would break very easily. But, gee whiz! they don't cost much more than carbon lamps during the last year or two, and they stand the racket much better. To get down to the scientific dope on the subject, I find that for the voltage we use on ships the electric juice necessary for a carbon lamp amounts to 3.1 watts per hour, or 49.6 watts for an ordinary 16-candlepower lamp. With a Mazda lamp we only use 1.25 watts per candlepower each hour, or in a 32-candlepower lamp we only use 40 watts of current per hour. In other words, we get twice as much light for only 80 percent of the current used. If the use of carbon lamps these days doesn't constitute a crime, in view of the dope on the subject, I don't know what does. Yet there are a whole lot of people still using carbon lamps. The only use for carbon lamps on a ship now is possibly in hand portables, as the Tungsten filaments do not stand the hard knocks quite as well as carbon.

Mazda lamps are generally good for 1,000 hours' use on an average, but you cannot depend on carbon lamps for much more than 600 hours. As a matter of fact, most people use lamps too long, anyhow. It costs much more to operate lamps giving a dull light than it does for those giving a bright light. A good rule is to put in a new lamp after the old one has fallen off about 20 percent in its efficiency. As soon as the bulb begins to look a little smoky on the inside, then is the time to douse it.

Of course, it is hard to give a general rule for the cost of electric light, as the cost of fuel and the efficiency of the plant vary so much, but it is safe to say that on an average it costs one-half a cent (¼d.) to run one lamp one hour. That isn't very much in itself, but when you multiply it by four or five hundred it runs up into real money.

It always gives my economical disposition a severe jolt to see so much carelessness as there is in using electric lights. Many a time they are allowed to burn in places which no one is using, or left to burn when there is plenty of good daylight to see everything distinctly. People never think of turning out electric lights in their rooms when they leave them, notwithstanding the fact that when they were youngsters they were brought up to use oil lamps, and to "douse the glim" every time they went out of the room. They have grown careless and have an idea that electric lights do not cost anyhing. Of course, in cleaning boilers the dynamo should be run to let the poor devils inside have all the light they need, but that is no reason why every light in the whole machinery space should be turned on full tilt.

Speaking of cleaning boilers, what a blessing is this electric juice compared to the time when we had to use hand lamps burning lard oil! I can remember every time after I got through working two or three days inside of a boiler that I would cough up enough lampblack out of my throat and lungs to mix a pot of black paint.

While we are talking about petticoat lamps, or hand lamps, whichever you choose to call them, there seems to be a few of them used on some ships yet. They stand rougher handling than the ordinary portable electric lamp, and are still used in coal bunkers, etc. Kerosene (paraffin) is dangerous to use this way, so a great many people use lard oil. Pig products have gone up with the cost of living, so we have to pay from $1.25 (5s. 2d.) to $1.50 (6s. 3d.) per gallon for this kind of oil, which is a quite expensive luxury. There are several kinds of substances like paraffin which can be bought on the market for from six to ten cents (3d. to 5d.) per pound, which make a mighty good substitute for lard oil, and are now used quite extensively in hand lamps. It has to be melted to run into the lamps, and when it is well lighted it burns with but very little smoke and is not put out by drafts any quicker than oil lamps. On an ordinary-sized ship the use of this substance results in a considerable monthly saving.

Yours for economy,

Old Scotch

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Q.—What is a reasonable efficiency of propulsion for a moderate speed coastwise steamer? L. P.

A.—A ratio of effective horsepower to indicated horsepower should be realized is 50 percent.

Q.—How great a length is allowable in condenser tubes without putting in an extra tube sheet for preventing distortion? T. E. B.

A.—One hundred diameters for tubes held by ferrules and corset-lacing packing, one hundred and twenty diameters when held by tight wooden ferrules.

Q.—Are jet condensers ever used with turbines when fresh water is available for the circulating water? W. O. C.

A.—Jet condensers should never be used. High vacua are essential to good efficiencies in turbine plants and jet condensers of any type are unsuitable for the production of high vacua. A large quantity of air in solution is carried in with the condensing water; this is liberated in the condenser and is equivalent to a very large air leakage. The air pump has to withdraw this enormously augmented volume of air and cannot be made of sufficient size. No form of condenser in which the condensing water mixes with the condensate is suitable for the production of high vacua.

Q.—Will you kindly tell me why the thrust block in marine turbines is sometimes located at the forward end of the turbine and sometimes at the after end, and which is the better location? T. B.

A.—In the Parsons type the thrust block is invariably located at the forward end, as it is then nearer the dummy rings by which the adjustment of the turbine is gaged. If it were at the other end of the turbine the expansion in the shaft between the thrust block and the high-pressure dummy rings would be sufficient to make the adjustment of clearances uncertain. In the Curtis type where axial clearances are much greater this is not so essential and frequently the thrust block is located at the after end of the turbine in order to have it further away from the high temperature of the high-pressure steam which by conduction along the shaft imparts a temperature to the thrust bearings much higher than that due to the friction of the thrust alone. However, the present tendency for the Curtis is toward the forward location.

Q.—What is the thermal efficiency of a turbine operating between 180 pounds gage and 28 inches vacuum, with 130 degrees of superheat in the steam chest? Will the efficiency be materially increased by raising the steam chest pressure to 250 pounds? S. T.

A.—The efficiency for Rankine's cycle from 195 pounds (absolute) and 130 degrees superheat to 1 pound (absolute) is 30 percent, and for 265 pounds (absolute) and the same superheat to 1 pound (absolute) it is 31.6, so there is a gain of but a little over 1½ percent by this big increase in pressure. The gain from increasing the vacuum is, however, much more marked, as, for example, increasing the vacuum 0.8 inch to 28.8 inches increases the thermal efficiency from 30 percent to 34½ percent. This is not merely of academic interest, as the actual steam consumption tests of turbines in operation show very nearly the full theoretical gain when the vacuum is increased, as is plain from the following table.*

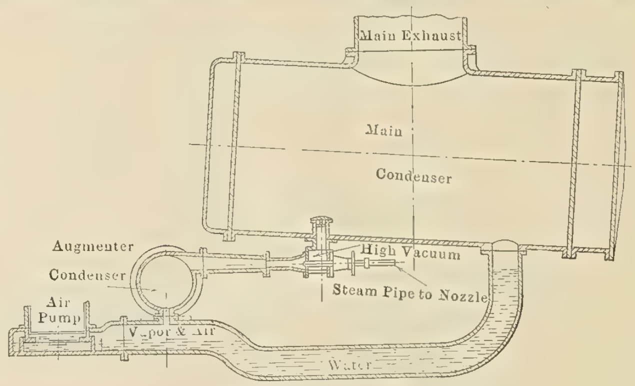
STEAM AT 200 POUNDS AND 200 DEGREES SUPERHEAT

Increase of Vacuum	Theoretical Saving in Steam Percent	Actual Saving in Steam Percent
27 inches to 28 inches	6.8	5
28 inches to 29 inches	11.4	6
29 inches to 29½ inches	16.0	6.6

All of which strongly emphasizes the necessity of infinite care and attention being devoted to the condenser end of a turbine installation.

Q.—Please explain the principle and operation of a vacuum augmenter, as is used in Parsons' trubine installations and why do not other turbines have them? A.

A.—There is a great gain in thermal efficiency by increasing the vacuum (see previous question), so that in turbines where it is mechanically possible to work with the large specific volume attendant upon low-pressure it is



Vacuum Augmenter

desirable that the highest vacua be maintained. Air leakage in a condensing system has an enormously disturbing effect upon the vacuum, as, regardless of the steam condensed, the air remains and being at low-pressure has a large specific volume, so that the removal of a normal leakage must be effected by air pumps of large volumetric capacity. Moreover, for very low-pressures the specific volume increases at an extremely rapid rate, so that a small air leakage may require large volumes to be removed, in order that the rate of removal equal the rate of leakage. It is the handling of these large volumes of very low-pressure air which is difficult for the ordinary type of air pump. The air leakage may be handled by a vacuum augmenter invented by Sir C. A. Parsons and shown in the accompanying sketch. This is essentially a device for removing the very low-pressure air and compressing it to a specific volume that can be handled by the common type of air pump. Here the air pump inlet is placed about 4 feet below the lowest point of the condenser. As a consequence, the pressure at the air pump is greater than that in the condenser by about 2 inches of mercury. Hence the same weight of air can be removed by a much smaller pump. The condensed steam

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* From a paper by G. S. Swallow, Transactions of Northeast Coast Institute of Engineers and Shipbuilders.

enters the air pump by the bent pipe, but the air is drawn off by a steam jet situated as shown. This discharges into an auxiliary condenser, which drains to the air-pump inlet, as indicated. The volumetric capacity of the steam jet is very great, and unless the air leakage is serious, a vacuum a little below the theoretical can be continuously maintained in the main condenser.

An equivalent device is the fitting of "wet" and "dry" air pumps. The wet pump is intended to handle condensate only and is of the common duplex type and located below the condenser, as in the case of the "vacuum augmenter." The "dry" air pump is intended solely for air or vapor, and takes the place of the ejector of the "augmenter" both in function and location, though the pump itself is frequently higher. The "augmenter" will give the lowest vacuum, but it is at an expenditure of steam of about 1½ to 2 percent of the total steam consumption, whereas the "wet"-"dry" pumps will give nearly as good a vacuum at a considerably less steam consumption, and are mechanisms with which the regular operating force is thoroughly familiar. Probably this accounts for the fact that in most of the newer installations, except where extreme refinement is attempted, the wet-dry pumps find more favor.

Q.—Will you please give me a solution of the following problems. The towboat (S) has two tandem compound condensing engines, 28 inches by 63 inches by 12-foot stroke; boiler pressure, 200 pounds; revolutions per minute, 10. The approximate indicated horsepower, 3,750. The wheel is a simple radial paddle wheel, located at the stern, 36 feet diameter, 40 feet long with buckets 40 feet by 4 feet. What horsepower would be delivered by this wheel? What would be the result if the number of revolutions were increased to 20, and what would be necessary in order to increase same?

A.—If the indicated horsepower of 3,750 which is given is correct, it is probable that the effective horsepower which the paddle wheel delivers and which is used in overcoming the resistance of the hull is about 45 percent of this, or about 1,690 horsepower. It is doubtful, however, if an engine of the type and dimensions given would have such a high indicated horsepower at 10 revolutions per minute, for if we assume cutoff in the high-pressure cylinder as occurring at 8/10 the stroke and a mean effective pressure factor of .7, which is reasonable for this sort of engine, the number of expansions (n) is

$$\frac{(63)^2}{0.8\ (28)^2} = 6.34,$$

and the theoretical or hyperbolic

$$M.\ E.\ P. = P_{\text{boiler}}\ (1 + \log_e n)\ \frac{1}{n} - P_{\text{back}} = 215\ (.45) - 4 = 92.7 \text{ pounds.}$$

Probable $M.\ E.\ P. = 92.7 \times .7 = 64.9$

" $I.\ H.\ P. = \dfrac{2 \times 64.9 \times 12 \times 3117 \times 10}{33{,}000} = 1470$ (per engine) $1470 \times 2 = 2940 =$ total $I.\ H.\ P.$

(If the high-pressure cutoff occurs at .6 stroke this becomes 2,400.) This would give $2{,}940 \times .45 = 1{,}320$ as the effective horsepower at 10 revolutions per minute.

In general the horsepower increases as the cube of the speed for the speeds generally encountered, and except for the increase in slip which may be considerable for a large change of revolutions per minute the speed increases directly proportional to the revolutions. For the case in hand, therefore, doubling the revolutions per minute would nearly double the speed of the boat (assuming no changes occur in loading or trim) and would require about eight times the indicated horsepower, which would require a new engine. If, however, the same boat were so loaded that the speed were the same with the increased revolutions per minute, the power necessary would be more nearly proportional to the product of slip, and (RPM)^2, for example, if the present boat were to be so loaded that her speed were the same as when operating light at 10 revolutions per minute the power under the new conditions would be increased in the proportion

$$\frac{20^2 \times \text{slip (new)}}{10^2 \times \text{slip (old)}}$$

and if 25 per cent were the original slip the new slip is 62½ percent, and the power necessary would be

$$\frac{20^2 \times 62.5}{10^2 \times 25} = 9 \text{ times as great.}$$

Q.—It is necessary to push six barges of a total displacement of 15,000 tons up stream at the rate of five miles per hour against a five-mile current. Said work to be done by a boat 200 feet long, 40 feet beam and about 6 feet 6 inches draft. The block coefficient of the hull is about .75 to .80. What indicated horsepower would be necessary to accomplish this? Could I use the formula $\dfrac{D^{2/3}\ V^3}{C}$ in this case, taking the value of C from the performance of the steamer mentioned above? The dimensions of the barges would be 250 feet by 50 feet by 8-foot draft. The principal dimensions of the steamer are 275 feet by 61 feet by 6-foot draft. Would the work up stream against a five-mile current be the same as a speed of 10 miles in still water? T. B.

A.—If the coefficient C in the equation I. H. P. $= \dfrac{D^{2/3}\ V^3}{C}$ is derived from a similar ship doing work similar to that intended for this boat, this is an excellent method for determining power. D. W. Taylor * proposes for paddle-wheel boats

$$I.\ H.\ P. = \frac{A\ V^3}{K}$$ where V = speed in knots, A = area of two floats (one on each side) in square feet, and K is a coefficient depending primarily upon slip.

If for the case in hand K be derived from trials under similar conditions it would be directly applicable to the new design. There are no data available for estimating the indicated horsepower of a case as given above out of whole cloth. The best estimate could be made upon the results of trials at the experimental basin at Washington, using scale models of the towboat and her tow.

Q.—Would the following data be suitable for a small yacht engine of 75 indicated horsepower? Cylinder diameters, 3½ inches, 5⅞ inches and 10 inches; stroke, 7 inches; boiler pressure, 250 pounds; revolutions per minute, 430; back pressure, 4 pounds; mean effective pressure, 53 pounds; cut-off, .75; efficiency factor, .70; ratio of expansion, 11; clearance, 0.4; piston speed, 600 feet per minute.

A.—Some of the data are inconsistent as piston speed, stroke and revolutions per minute. We will accept the piston speed and stroke and disregard the revolutions per minute. The cylinder proportions are consistent with good practice. The efficiency factor and mean effective pressure are higher than would probably be the case for this engine, therefore take an efficiency factor of .60; the solution for indicated horsepower then becomes:

Pressure at admission 250 gage + 15 atmos. — 5 loss in line = 260 pounds P_1.

Theoretical mean effective pressure $= P_1 \left(\dfrac{1}{n} + \dfrac{\log.\ n}{n} \right) - P_b$, when P_b = back pressure and n equals number of expansions. $260 \times .30 - 4 = 74$ pounds per square inch.

Probable mean effective pressure = theoretical mean effective pressure × efficiency factor, $74 \times .60 = 44.4$ pounds per square inch.

Probable indicated horsepower $= \dfrac{600 \times 44.4 \times 78.5}{33{,}000} = 63.3.$

To get the 75 indicated horsepower desired it will be necessary to increase the piston speed to 712, which is entirely allowable. This gives revolutions per minute, 610. If these revolutions per minute can be accepted the engine is suitable.

* Speed and Power of Ships.

Letters from Marine Engineers

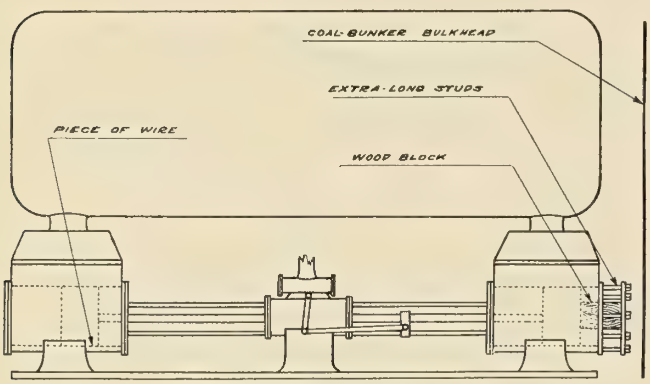
Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries — Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Valve-Spring Jams Pump-Piston

While a certain steamer was passing through the St. Clair flats, Lake St. Clair, the pumps on the condenser suddenly stopped. The condenser was of the horizontal surface type, the circulating pump and air pump being on the same piston rod and having a common steam cylinder as shown in the sketch. We attempted to start the pump again, but were unsuccessful, and so immediately shut down the main engine and began investigations to attempt to locate the cause of such a sudden stop.

The steam cylinder and valve mechanism were carefully examined and found to be in the proper condition. The valves on the air end were all overhauled and no defects were visible there. The valves of the circulating end were then examined and the brass spring in one of the valves was found to be broken and quite a fair sized piece missing. The rest of the valves being in good condition, the only possible conclusion we could arrive at was that a piece of this broken spring had become lodged in between the cylinder and the piston and thus caused the sudden stop.



Repairs to Air Pump

In order to remove the spring, it was necessary to remove the piston and packing, and to do this we had to first move the piston to the end of its stroke. We turned on the full head of steam in the steam cylinder, and by means of long bars attempted to aid the steam in forcing it over, but we were unsuccessful.

The air end of the pump was about a foot from the coal bunker bulkhead, so that it was possible to rig up a jack screw against the bulkhead and the piston of the air end. This was done and an attempt was made to force the piston over. As soon as pressure was applied to the jack screw, the bulkhead bulged and did not form a strong backing for the jack screw. Therefore this method was given up.

To accomplish our purpose, we then removed the cylinder head from the air end and took about half of the studs out of the cylinder casting and replaced them by long studs about 8 inches in length with a comparatively long thread on the outer ends which we made for the occasion. We then took an oak block of convenient length and placed it between the piston and the cylinder head, as shown in the sketch, and then by screwing up the nuts on the long bolts, we were able to force the piston over by very small amounts at a time. Pieces of wood were inserted between the piston and the block as the ends of the threads were reached. After getting the piston over and removing the follower and packing, we got the piece of spring out and then put the pump in working condition and proceeded on to Detroit after a delay of two hours caused by a piece of brass wire one and one-half inches long.

A. L. F.

Unique Pump Repair

While the writer was on the tank steamer *L*——— our auxiliary condenser stopped one night, and when taken apart the next day it was found that the nut on the piston rod in the steam cylinder had worked off the thread, leaving the follower and piston rings all adrift in the cylinder.

The condenser and pumps were of a regular standard make, with circulating pump in one end, air pump in the other end, and steam cylinder in the middle. The nut, after working loose, had upset the thread on the piston rod, and try as we could we could not get the nut started on the rod again, so we had to take the piston rod out. This, of course, meant to disconnect and remove pistons and packing in both air and circulating pumps.

After we got the piston rod out we found that it was also bent, and that the bend was a short one right in the threaded part next to the steam piston. It was a nasty bend to get out, as there was no lathe on board the vessel. We wanted the condenser again as soon as possible, so we soaked our heads to think out what could be done.

We decided on rigging up two centers on the tank top on deck. The centers were made of two common set screws 5/8 inch by 3 inches, ground to a point and screwed through an angle bracket made of 5/8-inch by 2½-inch flat iron. After we had the brackets and set screws finished, they were clamped on the tank top with two C clamps. The old centers in the piston rod were found, cleaned out and the rod put up on the improvised centers and turned over.

We found it to be worse than we had expected, as it had two kinks instead of one. It was marked, taken down and put between two hardwood blocks and straightened by the slow process of alternately pounding between the blocks and testing it between centers. It could not be straightened between centers, as they were too weak to stand any hammering.

After half a day was spent in pounding and trying the rod between centers, we had it true. The steam piston was then driven on the rod, to be used as a pulley. A belt was made from marline in the form of a flat sennet.

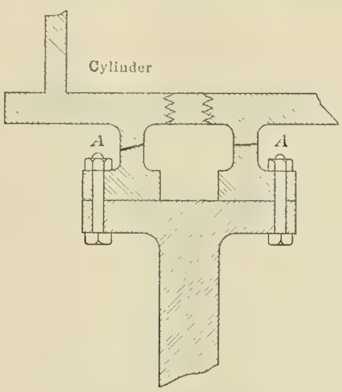
Next came our motive power to drive our improvised lathe. This was in keeping with our lathe and consisted of a fireman turning a grindstone, the box of which stood on end and the marline belt passed over the grindstone and on to the piston pulley.

A chasing tool was made out of an old flat file and the burred up and damaged thread on the piston rod was re-chased. A little filing finished up the thread, and also smoothed up the rod, taking all the hammer marks out of it. The rod was then put back and the pumps reassembled. This arrangement was running satisfactorily three years afterward when the writer left the vessel. J. J. F.

Repairs to a Cracked Cylinder

A new tugboat had been in commission during the summer and was laid up when ice began to form in the river on which she had been operated. The engineer was particular about draining all the pipes, valves, fittings, cylinders, etc., as no steam was to be kept on the boat while out of commission. In the following spring everything appeared to be in good shape when the engineer started to get the boat ready, but, on turning the engine over at the dock under steam, the foot of the low-pressure cylinder, where it rested on the column, was found cracked. The sketch, a sectional view of this side of the cylinder, shows the cracks at the places marked *A*. Knowing that this foot was not cracked when the boat went out of commission, the engineer began an investigation in order to discover the cause of the damage. This disclosed the fact that the foot had been cast hollow, with a flange on the inside of it, as shown in the sketch, thus requiring a core to make the hollow.

This core extended through the bottom of the cylinder and the hole had been closed by tapping it out and screwing a wrought iron plug in it. The plug had not been made perfectly tight and water had leaked through it during the time the boat had been running, so that the



Location of Cracks

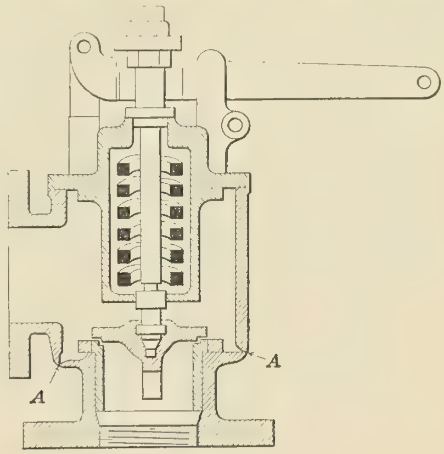
foot on the cylinder was filled with water at the time she went out of commission. This water soon formed into ice and, in expanding, did the damage. Fortunately the damage was done in places that could be easily patched, but if the bottom of the cylinder had cracked the probabilities are that a new cylinder would have been required.

The draftsman who designed this cylinder blundered. If the foot had been designed without the inside flange, which was of very little value, no core would have been required in the mold and the bottom of the cylinder would not have had the hole in it. Perhaps, if the plug had been made of cast iron, it would not have leaked, but no matter how tight the wrought iron plug was fitted it was bound to loosen in the hole enough to allow some leakage, the expansion and contraction of the two metals not being equal.

When the foot had been patched a drain hole was drilled in the side close to the bottom so that the water that leaked in would not accumulate. J. S.

An Unusual Accident to a Safety Valve

A very unusual accident occurred some years ago to the safety valve on the boiler in a tugboat. The boat had left port without a tow, and soon after the fireman noticed steam leaking around the valve. He reported it to the chief engineer, who was on deck, although not on watch. Going into the fireroom the chief grasped the top of the valve to pull himself up on the rounded top of the boiler and, as his weight was thrown on the valve, the body of it broke off and the steam escaped through the full area of the valve seat, severely scalding the engineer. The assistant engineer immediately started the injector, keeping the water above the danger line, and after the steam had blown off the boat was picked up by another steamer and towed into port.



Section of Safety Valve

Examination of the valve showed that the valve seat, which was made of composition and forced into the body of the valve, had a lip around the outer edge which formed a recess or pocket all around the lower part of the chamber in which water collected and laid, the drain hole from the chamber having been drilled some distance above the bottom. This accumulation of water rusted the wall of the chamber away at the points marked *A* in the accompanying sketch until it was as thin as a sheet of writing paper, and the extra strain thrown on it by the weight of the engineer was sufficient to break it off.

This boiler had been tested a short time previous to one and one-half times the working pressure, but investigation showed that the valve had been held down while the pressure was being applied by a clamp or gag that hooked under the chamber below the damaged portion, so that there was no strain at all on this part of the chamber at this time. J. S.

New London, Conn.

Experiments in Coal Consumption

The data given below are the result of a series of experiments which were carried out by the writer in order to determine roughly whether or not a saving could be effected by using only a part of the furnaces in a Scotch boiler instead of all of them. These experiments are not given with any idea that they are scientifically correct, but it is believed that they are sufficiently accurate to prove of interest to the users of Scotch marine boilers.

The conditions under which the tests were made were the ordinary port conditions of a cargo steamer. The coal used in all tests was the same; the maximum and minimum load conditions were the same; the personnel of the fireroom was the same; the weather conditions were ap-

proximately the same (midwinter in northern waters) throughout the whole series of experiments.

The boiler in use in port was one of the ship's main boilers (no donkey boiler was installed), a large double-ended six-furnace Scotch. Opposite furnaces had a common combustion chamber, that is, the corresponding furnaces in each end of the boiler led into the same combustion chamber. The two connecting furnaces were separated from each other by a high bridge wall.

There was a considerable amount of auxiliary machinery installed on board, so the steam consumption was fairly high at all times. It was the custom to keep fires in all six furnaces of the boiler for port use. This made the work of firing very light, as the fires could be kept banked nearly all the time. The coal consumption under such conditions was about 6.0 to 6.25 tons per day.

It was suggested to the writer that a saving in coal could be made by using only a part of the furnaces in each boiler instead of all of them, as was the custom. In order to determine the merits of this contention, a series of tests under three different conditions was carried out. These conditions were as follows:

(A) Fires were kept burning in the four wing furnaces, that is, in two furnaces in each end of the boiler, the center furnaces remaining dead. The dead furnaces were made as nearly airtight as practicable by plastering up the furnace front with sheets of heavy paper.

(B) Fires were kept burning in three furnaces, that is, in two wing furnaces in one end and in the center furnace in the other end of the boiler. Other furnaces were closed as before.

(C) Fires were kept burning in the two center furnaces, one in each end, with the four remaining furnaces dead. Dead furnaces were sealed as before.

The results of the experiments were:

Under condition "A."—Time during which the test continued was 104 hours. Coal was burned at the rate of 6.25 tons per day. Steam was easily kept up by these four furnaces, with only moderate working of fires. No leaks or other signs of exceptional boiler strains were visible. It should be noted in this case that one combustion chamber was entirely dead and that the other two each had two furnaces discharging into them.

Under condition "B."—Time during which the test was continued was 48 hours. Coal was burned at the rate of 6.96 tons per day. This coal consumption was so much above that of the first test (also of that for all six furnaces) that it was not considered worth while continuing more than 48 hours. In this case each combustion chamber had one dead furnace and one with fires connected to it. Steam was kept up without very much difficulty.

Under condition "C."—Time during which this test continued was 48 hours. Coal was burned at the rate of 6.23 tons per day. Although only two furnaces were in use in this case, the coal consumed was almost equal to that when four were burning. It was necessary to work the furnaces quite often, and considerable difficulty was had in keeping up enough steam for all the auxiliary machinery. On account of this difficulty of meeting any sudden demand for steam the test was discontinued at the end of 48 hours. During this test signs of unusual strains in the boiler appeared. Many small leaks were observed along seams and around rivets in the vicinity of the two wing furnaces at each end. It is believed that these were caused by the unequal expansion and contraction of the boiler, due to the necessity for forcing the fires in the center furnaces while the wing furnaces were cold.

Immediately following these tests the coal used with all six furnaces burning was carefully measured for a period of 10 days. The consumption proved to be 6.1 tons per day.

A summary of the results obtained showed that the coal consumption in tons per day was: with six furnaces burning, 6.1; with four furnaces burning, 6.25; with three furnaces burning, 6.96; with two furnaces burning, 6.23.

It will be observed that the consumption when all furnaces were in use was less than for any other combination. This is believed to be caused by the fact that under these conditions all air getting into the boiler must be heated, whereas under all other conditions there is a passage for air to get to the uptake without being highly heated. Even when the furnace fronts are well covered to prevent the passage of air through dead furnaces leaks still occur.

With two furnaces in use, and with four furnaces in use, results were almost the same, but were slightly higher than when all six were burning.

With three furnaces in use the coal consumption took a large jump upward. This is believed to be due to the fact that each furnace was discharging into a combustion chamber which opened directly into a dead furnace on the opposite side. The combustion chamber was too large for one furnace under the best of conditions, and with the cold air from the opposite furnace getting in it proved to be very inefficient.

As a result of these tests the former custom of using all furnaces in the boiler under steam was continued. As previously stated, these tests were not performed under laboratory conditions, nor were they performed by especially trained men, so their exactness is open to some question. It is believed, however, that they should prove of interest to many engineers, and that they may excite enough curiosity to induce some inquisitive engineer to repeat them under different conditions. If they should do this, their publication is well justified.

W. W. B.

Saved by Uncle Sam's Bounty

The splendid work of United States revenue cutters in assisting distressed merchant vessels has evoked numerous complaints of late from wrecking and towboat companies, who have protested to Uncle Sam that his sturdy white sentinels of the coastwise traffic were taking the very bread from their mouths.

Their objections have fallen on deaf ears at Washington, however. It is pointed out that the assistance of the vigilant cutters is usually rendered at the psychological moment, when to summon the most efficient wrecking outfit, unless it were actually on the scene, would be futile and preposterous. Moreover, there are very few merchant skippers who do not endorse the brave labors of the Revenue Service from the bottom of their hearts.

The grievances of the wrecking concerns, however, are not likely to be lessened by the salving, on October 20, of the *Alice Howard*, one of two ferry steamers owned by the Atlantic Shore Railway and operating between Portsmouth, N. H., and Kittery, Me. The *Howard* ran ashore on a ledge off Clark's Island, Portsmouth Harbor, during a fog. A hole was stove in her, she filled and tilted by the head almost on her beam ends, until her hurricane deck forward was submerged in deep water.

The case obviously was a ligitimate one for a wrecking company. Powerful apparatus was to be had from Boston within a few hours, but the owners of the steamer knew a trick worth two of that. They appealed to Capt. Harry A. Field, U. S. N., Commandant of the Portsmouth Navy Yard. He obligingly furnished them with a big floating derrick, and the sunken *Alice Howard* was raised and beached at Kittery Point for repairs.

Marine Articles in the Engineering Press

Descriptions of Some Special Types of Ships—Decline of the Sailing Ship—Marine Engine Construction in Germany

The Manufacture of Heavy Chains.—The replacement of chains by steel wire rope for many purposes of lifting and hauling is commented upon, but also that many special cases open up again new fields for chains specially of heavy character. The experiments to produce chains by machinery are not pronounced to be very successful, as the welding particularly requires the utmost scrutiny by personal supervision, while great advantages are secured by machinery for the manipulation of the forging and heating fires and for the cutting and bending of the stock as well as for the testing of the completed chains. A description of the plant, operation and product of the chain forge of the D. E. M. A. G. in Duisburg, with forty-two fires and the necessary machinery for cutting, bending, smoothing and testing, is given. 5 illustrations. 1,250 words.—*Schiffbau,* October 14.

The Application of the Cruiser Stern to Merchant Vessels.—Attention is directed to the influence that a modification of the stern toward the form used in warships might produce in decreased resistance and improved earning capacity. The French magazine, *Le Yacht,* is quoted with a comparison of a ship of ordinary form of stern with a number of designs with cruiser stern and varying fullness, showing a larger useful load per ton of burnt coal for the latter type. Notice is taken also of some model experiments in the tank of the German Government comparing the two forms each at two correspondingly equal displacements at progressive speeds from 15 to 24 knots. The cruiser-stern type showed at a speed of 21 knots a saving of 4.9 percent of power at 15,090 tons displacement and of 6.9 percent at 14,129 tons displacement. 5 tables, 4 diagrams. 850 words.—*Schiffbau,* September 23.

Shallow Draft Steamer for the Yangtse Kiang.—Messrs. Yarrow & Co., Ltd., Scotstoun, recently constructed for the Szechuan Steam Navigation Company, the shallow draft tunnel steamer *Shu-Hun* for their passenger and cargo service between Ichang and Chungking on the Yangtse River. Hitherto it has been necessary for small steamers in this service to be warped up the rapids, but in this new vessel the aim was to provide sufficient power for the vessel to negotiate the rapids under her own steam without the assistance of warps. The vessel was built with a length of 190 feet, a beam of 30 feet and a draft of 5 feet when loaded with 300 tons of cargo. The hull is divided into nineteen compartments by transverse and longitudinal bulkheads and watertight doors are also fitted to the bunker bulkheads. Accommodations for European passengers and the officers are on the boat deck, while the accommodations for the Chinese first class and second class passengers are on the upper deck. On the main deck there is accommodation for 170 Chinese steerage passengers, 15 firemen and three Chinese engineers. The petty officers, deckhands and cooks are berthed in the forecastle. There are five separate holds for cargo with a total capacity of about 16,000 cubic feet. The propelling machinery consists of two sets of triple expansion surface condensing engines, aggregating 2,000 indicated horsepower. Steam is supplied by two Yarrow patent double-ended watertube boilers, operating under forced draft and arranged to burn either coal or coal and oil. The propellers operate in tunnels arranged according to the Yarrow patent system, although in this case the flap is made self-balancing. The forward part of the tunnel forms part of the hull in the usual way, but the after part is hinged at a point about the center of the tunnel and the flap is balanced by means of weights attached to the end of a chain which passes over pulleys, so that the flap automatically regulates itself according to the draft and the pressure of water on the after part of the tunnel. 13 illustrations. 1,600 words.—*Engineering,* November 6.

200-*Ton Floating Crane of the Norwegian Navy.*—The necessity of lifting appliances is stated to have impressed the Norwegian naval authorities at the time of ordering submarine vessels with the necessity of purchasing the largest floating crane. The design as proposed by and accepted from the Frederikstad mek. Verkstad is said to embody into a harmonious unit hull and cane machinery, securing thereby stability conditions more favorable than required. The stated dimensions of the hull are 110 feet long by 53 feet beam by 14 feet deep, with double bottom and trim tanks of such proportions and capacity to limit the list of the crane to not more than 4½ degrees with 200 tons 8 feet 4 inches forward of the bow. The crane girder is of triangular skeletonized section, moved at its end up or down by a large nut on a single screw spindle 11⅜ inches diameter by 33 feet 4 inches long. The details of the crane machinery for the two loads of 200 tons at 8 feet 4 inches and 25 tons at 62 feet 6 inches distance from the bow are given, with special reference to the provisions for automatic braking by four Weston clutches in connection with spur-gearing. The description of the machinery includes two compound engines and two boilers with the auxiliaries of centrifugal trim pumps, capstans, etc. The tests are stated to have been very satisfactory and in excess of all requirements for speed and capacity. 6 illustrations. 1,600 words.—*Schiffbau,* October 14.

Typical Ships—No. VI—A Steam Trawler.—All trawlers are usually built greatly in excess of Lloyd's requirements so that they will be able to withstand the rough treatment to which they are subjected when returning to port with a catch and crowding in among their competitors at the dock. Under these conditions a vessel of light construction would inevitably meet with serious damage. Seaworthiness is largely attained by having a very great freeboard forward which is a common characteristic of trawlers. The question of speed is not considered of importance and the majority of trawlers are capable of doing only about 10 knots. Although most of the trawlers' hulls conform to a general design, no attempt has been made to standardize their construction. The forecastle is used as the crew's quarters. Aft of this is the fish well, and further aft a bunker which can also be used for fish. In the stern are the machinery and the officers' quarters. The pilot house is usually just forward of the funnel. Although a return tubular boiler and triple expansion engine is always fitted in these boats, no attempt is made to standardize trawler machinery. The vessels described in the article were built by Messrs. Cochrane & Sons, of Selby, who did the hull work, and Messrs. C. D. Holmes & Co., of Hull, who built the engines. The particular vessel described is the *Mena,* built for Roberts & Ruthven, Ltd., of Grimsby. She is 122 feet long, 22 feet 3 inches beam, and 12 feet 4 inches molded depth, arranged for fishing in the North Sea or off Iceland. The

fish hold is divided up into a number of small divisions, so that different classes of fish can be kept separate. Many of the trawlers have their holds insulated, although no such provisions were made in the *Mena.* The main engine is a three-cylinder triple expansion engine 12½ inches, 22 inches and 35 inches diameter by 24 inches stroke, running at about 110 revolutions per minute, using steam from a single-ended two furnace Scotch boiler, working at 180 pounds pressure. The air, feed and circulating pumps are driven direct off the crossheads. 10 illustrations. 3,000 words.—*Engineering,* October 16.

The Decline of the Sailing Ship.—The returns of Lloyd's Register for the last few years show that there has been a steady decline in the construction and operation of sailing ships, and, if this rate of decrease were to be continued, it is obvious that such ships would soon disappear altogether. Under the conditions affecting the use of sailing ships, however, it is rather improbable to anticipate that the demand for sailing ships will die away entirely for a long time. A fact which makes for the continued existence of the sailing ship is the development of the internal combustion engine used as an auxiliary. Considerable progress has already been made in this line, although the outcome is, of course, simply a problem in economics. In this case, however, the price of oil is a matter of far less moment than in the case of a ship which depends wholly for her propulsion on internal combustion engines. Many voyages of the auxiliary sailing ships are made without using the auxiliary power at all. In the small vessels, however, the tendency is undoubtedly to increase the use of motor boats and to abandon sailing vessels. Although the number of sailing ships is steadily decreasing, it should be noted, however, that the average size of sailing ships has increased in recent years rather than decreased. There are many sailing ships of between 1,600 and 2,000 tons, which are giving admirable service, and they serve as an excellent school for training apprentice seamen for the merchant marine. 900 words.—*The Engineer,* October 23.

The Quadruple-Screw Turbine Express Steamer Imperator.—By comparison with the then largest British ships the author shows the *Imperator* exceeding all previous vessels at the time of entering into service. Details are given of the hull, ballast capacities and structural details. In the description of the machinery plant due attention is paid to the boilers, being of watertube type, forty-six single-ended in four boiler rooms, built for 235 pounds, fitted with Howden draft from 4-foot to 14-foot fans, with 4-foot suctions, and served by the usual reciprocating pump auxiliaries. The turbines, four in number, of mixed type, with 61,000 indicated horsepower ahead and 33,500 indicated horsepower backing, have very efficient handling gear for best economy and show the usual careful details of modern turbines in material, blading, packing, stuffing boxes, foundations, thrustblocks, forced lubrication and lifting arrangements, as well as in condensers, independent auxiliaries, shafting and propellers. Of the hull auxiliaries are described the rudder with gear and engine, windlass, chains and warping gear; further, the ventilators for machinery and quarters; the electric plant, steam heating, refrigerating plant, with pumps and tanks, steam and electric winches, bilge, sanitary and ballast pumps and air compressors. The navigating, safety and fire alarm and extinction apparatus appears to be unusually complete, including also emergency gasoline (petrol), electric light plant, wireless outfit signal apparatus, lifebelts and lifeboats with davits. The last part of the article describes the passenger accommodations, with all recent improvements and necessary adjuncts for service. 13 tables, 52 illustrations, 11,600 words.—*Zeitschrift des Vereines Deutscher Ingenieure,* June 20 and 27.

The Development of German Marine Engine Construction.—This is a review of the development of marine engine building of the last decade, as mainly exemplified by the activity of the shipyard "Weser" in Bremen. It deals with the latest phase of building Scotch boilers over 17 feet diameter and over 21 feet long, at working pressure up to 235 pounds, with hot-forced draft up to 2½-inch water pressure, accompanied by retarders and recently by frequent installations of firetube superheaters. It points out the great advance made by watertube boilers, first for the navy, with closed fire rooms and drafts up to 8 inches of water pressure, and recently for the merchant marine, as exemplified in the *Imperator* installation, with forced draft of Howden type. The promising possibility of oil fuel is mentioned, provided the price of fuel oils remains low. It is stated that the reciprocating engine is still leading on freight steamers, with refinements in the direction of full balance, independent auxiliaries and condensers, gradual introduction of superheated steam and oil separators and possibly wider installation of poppet valve engines. For large powers the turbine is considered a necessity, an intermediate stage being the combination of high-pressure reciprocating engines with exhaust turbines. The mixed turbine systems are considered the type of the future for large powers, as accentuated by the German navy in standard single-shaft units. Gear and transformer transmissions of high-speed turbines to low-speed large propellers are pronounced a success and very promising commercially for freight steamers. Oil engines are stated to be only temporarily under a cloud of disfavor, as the difficulties so far experienced can readily be overcome by better material and workmanship and by more familiarity of the engineers. 39 illustrations. 11,000 words.—*Zeitschrift des Vereines Deutscher Ingenieure,* July 4 and 11.

GROWING BAY STATE PORTS.—While the oft-repeated slogan "Sail from Boston" has boosted Hub commerce into the front rank in the last few years, the business of other Bay State ports has been taking rapid strides as well. A demonstration attended the arrival at Beverly recently of the steam collier *Malden* of the New England Coal & Coke Company, the largest vessel ever entering that port. She brought 7,280 tons from Newport News, inaugurated a regular service between the two places and wrested honors from the new oil tanker *Gulfstream,* which had held the distinction of being the largest ship Beverly had known. Beverly was already a distributing station for the Gulf Refining Company, and had a considerable traffic in that commodity. The deepening of the ship channel of the historic port of Plymouth has lately permitted the entry of ocean-going steamers with cargoes of hemp from Progreso, Mexico, for the Plymouth Cordage Company, which until now has received its consignments via Boston. Little towns on Barnstable and Buzzard's bays expect to receive a decided stimulus through the opening of the Cape Cod canal, while Rockport, the home of famous Cape Ann granite, pins its hopes on the completion of the colossal Sandy Bay breakwater, which has been under way for 25 years.

MARINE ENGINEERS' CONVENTION.—The National Marine Engineers' Beneficial Association will hold its fortieth annual convention at Washington, D. C., January 18 to 23, 1915, with headquarters at the Raleigh Hotel.

New Books for the Marine Engineer's Library

Useful Books for Applicants for a Marine Engineer's License —Some Important Subjects Treated in an Elementary Manner

INDICATOR DIAGRAMS FOR MARINE ENGINEERS. Third edition. By W. C. McGibbon, M. I. E. S. Size, 7½ by 9½ inches. Pages, 178. Figures, 197. Glasgow: James Munro & Company, Ltd. New York: D. Van Nostrand Company. Price, $3.00.

While most marine engineers are familiar in a general way with a steam engine indicator and its use in the determination of the power of an engine, it is not always easy for the engineer to analyze an indicator card and pick out the faults in the engine shown by the card. This, however, is one of the most important functions of the indicator, and especially when the engineer can find the necessary remedy to apply to an engine to overcome the defects shown by the cards. The book under review contains a great many examples of defective diagrams with a most instructive analysis of the cards showing the cause of defects and how they may be remedied. This book is highly recommended for its practical suggestions, and a copy should be in the library of every first class marine engineer.

MARINE ENGINEERS' DRAWING BOOK. By W. C. McGibbon, M. I. E. S. Size, 12 by 9½ inches. Pages, 124. Plates, 51. Glasgow, 1913: James Munro & Company, Ltd. New York, 1913: D. Van Nostrand Company. Price, $2.00.

On account of a great change which has recently come over the requirements of the Board of Trade in drawing examinations, the author of this book, who is principal of the Glasgow School of Marine Engineering, has found it necessary to get out a new edition of the book in order to meet more fully the needs of applicants for a marine engineer's license. In the Board of Trade examinations at present the candidate is expected to design and give a full dimension drawing of engine parts. Instructions for such work are given in this book in the form of large, fully dimensioned drawings arranged in the form of plates, while on the page opposite each plate is given the statement of the problem in the form it would be given to the candidate in his examination, and below this instructions showing the formulas and calculations necessary for determining the dimensions of the various parts which are to be reproduced in the drawing. This book will be found of immense value to candidates for a Board of Trade examination, and is well worth a careful study even by men who are not confronted with the necessity of passing an examination and yet find it necessary to make detailed sketches of marine machinery.

POWER AND POWER TRANSMISSION. Third edition. By E. W. Kerr, M. E. Size, 5¾ by 9 inches. Pages, 373. Illustrations, 325. New York, 1914: John Wiley & Sons, Inc. London, 1914: Chapman & Hall, Ltd. Price, $2.00 net.

Although the first edition of this work was published in 1901, it has been found necessary in the third edition to revise and rewrite a large part of the work, and make considerable additions. The book is arranged in three parts, dealing respectively with mechanics, steam power and other power machinery. The first part contains chapters on shafting, bearings, friction and lubrication, friction wheels, pulleys, belt gearing, toothed wheels, the screw, cams, the lever, link work and pipe fittings. Part II contains chapters on the simple steam engine, high speed engines, indicators, compound engines, condensers, valves and valve gearing, rotary engines and steam turbines. Part III contains chapters on pumping machinery, internal combustion engines, water power and compressed air. For a book of this size to cover so many subjects, it is not to be expected that each subject has been treated exhaustively, the greater part of the work is descriptive, although the general principles of the operation of the various types of machinery described are explained with the aid of line drawings and diagrams. As a brief treatment of the subjects discussed, the book will be found useful.

MATHEMATICS FOR THE PRACTICAL ENGINEER. By Charles H. Bromley and Henry R. Cobleigh. Size, 5½ by 8¼ inches. Pages, 220. Illustrations, 70. New York, 1914: McGraw-Hill Book Company, Inc. Price, $2.00 net.

FUEL ECONOMY AND CO_2 RECORDERS. By A. R. Maujer and Charles H. Bromley. Size, 5½ by 8¼ inches. Pages, 189. Illustrations, 28. New York and London, 1914: McGraw-Hill Book Company, Inc. Price, $1.50 net.

These two books are made up of material previously published in the Engineers' Study Course in *Power*.

The first book, which treats the subject of mathematics in an elementary manner, aims to bridge the gap between practical operating experience and the technical knowledge needed in modern practice by giving engineers the necessary mathematical foundation. Any man who has found his lack of education in mathematics a barrier towards advancement in the engine room will find this book most helpful. It begins with a chapter on vulgar or common fractions, then takes up denominate numbers, percentage, ratio and proportion, square and cube root, formulas, logarithms, mensuration and finally ends with a brief chapter on plain trigonometry. The information is given in plain every-day language which can be readily understood.

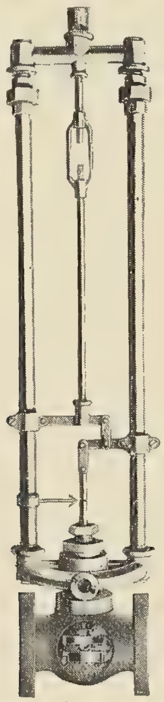
The second book deals principally with combustion. The authors point out that the cost of fuel in most plants is between 60 and 70 percent of the total cost of power. Too many people fail to realize the possibilities of waste in the boiler room and the causes of waste which might easily be eliminated. If combustion means to the fireman only the maintaining of a fire hot enough to keep the steam gage indicating the correct pressure, his advancement to the position of an engineer will be slow and laborious. He will find that there is much to be learned about the principles of combustion, the analysis of fuel and flue gases and the losses of heat in the flue gases. This book gives a clear insight into such matters and also takes up the subjects of evaporation, boiler efficiency, heat balance, feed water treatment and CO_2 recorders. While the book is prepared especially for stationary engineers, it will be found equally useful for marine engineers.

THE NAVAL POCKET-BOOK, founded by Sir W. Laird Clowes and edited by R. C. Anderson, has just been published by W. Thacker & Co., London, E. C., with corrections to April 8, 1914. This is the nineteenth year of publication of this volume and it is arranged in the same manner as the previous editions, with tabulated data of the navies of the world, tables of naval guns, a list of dry docks throughout the world and plans of armored ships. The only changes are the natural extensions and corrections of the data to cover the progress of the past year. The book is 3½ by 5 inches in size and contains over 700 pages. The price is 7s. 6d. net.

ENGINEERING SPECIALTIES

McDonough Feed Water Regulator

The McDonough Automatic Regulator Company, of Detroit, Mich., has placed on the market an automatic feed water regulator of the thermostatically controlled type. The main purpose of its design is to secure not only a continuous feed, but positive automatic control of a continuous feed to vary with the boiler load and maintain a water level within limits best suited for constant maximum boiler capacity, efficiency and uniformity of operating conditions. It is claimed that the regulator in actual operation maintains a continuous feed proportional to the evaporation and for light loads and uniformly varying loads a constant water level. On the other hand, for sudden increase in load and resulting rapid drop in water level, the regulator valve does not open suddenly to admit



a large quantity of water into the boiler, but there is a time element in the expansion of the tubes operating the valve which uniformly increases the feed, permitting the immediate furnace heat to be used for evaporating water and not heating cold feed. In this manner of feeding it is claimed that the maximum capacity of the boiler, with greater uniformity of furnace conditions, is maintained and boiler strains are avoided.

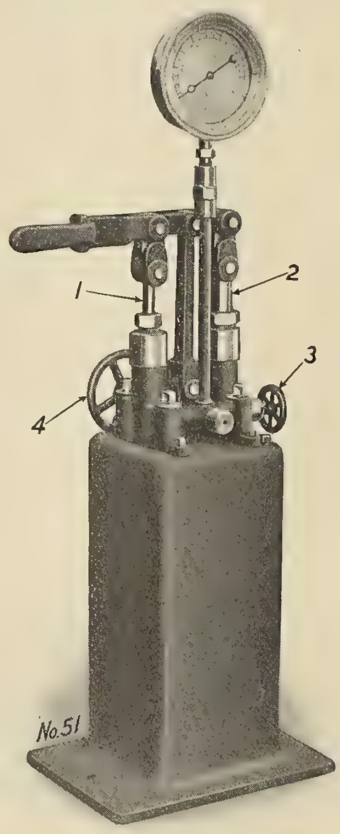
The regulator is complete in itself, consisting of a special feed valve, two headers and two expansion tubes connected in parallel through a rigid linkage to the feed valve stem. The use of two expansion tubes doubles the power of expansion and contraction and the levers transmit the motion to the feed valve in a ratio of 5 to 1. The turnbuckle and pointed indicator, it is claimed, permit the very accurate adjustment of the valve, and further, the pointer indicator shows at each instant the position of the valve while the regulator is in operation.

The regulator is installed in an inclined position, wholly supported by the feed piping with the connections made to the water column as shown. In operation the lower end of the tubes are filled with water and the upper with steam. As the water falls or rises in the boiler, it correspondingly falls or rises in the regulator tubes, presenting a greater or less area of the tube surface to the hot steam, causing them to expand and contract accordingly. The inclined position of the regulator gives the greatest variation in exposed tube surface for a given variation in water level, and the greatest sensitiveness to variations in load.

Double Piston, High-Pressure Hydraulic Pump

A. L. Henderer's Sons, Wilmington, Del., have placed on the market a combined quick-acting and high-pressure hydraulic pump for general purposes. While continuous pumping may be had while the two pistons are in action, the principal feature of the combination is the variation of pressure.

This pump can be applied to various usages, one of which is in conjunction with a ram for use as a hydraulic jack. The time required pumping the ram to the load with a maximum pressure single piston pump is readily realized, while in this combination of ¾-inch and 1½-inch



pistons the time reduction is three quarters. With the combination of ¾-inch and 1½-inch pistons 6,000 pounds per square inch can be had from the former and 1,000 pounds from the latter, and it is to be noted that the low-pressure piston is on the upward stroke of the lever and the high-pressure on the downward stroke.

In the illustration the No. 1 piston is the high-pressure. The No. 2 piston is the low-pressure, and when its capacity is to be exceeded it is disengaged by means of the release wheel No. 3, leaving the piston No. 1 free for higher duty, and which latter is in operation under all working conditions. Complete release of all load pressure is by means of the release wheel No. 4, which governs the return of the liquid to the pump's reservoir.

The pump as illustrated has a stroke of 3 inches, total height of 34½ inches and weight of 190 pounds, with reservoir base of 1,200 cubic inches, but the capacity of base can be changed to suit immediate needs, as can the diameters of the piston for working pressures.

Personal

E. V. Jones has been appointed chief engineer of the Louisiana Railroad & Navigation Company's steamer *Lewis*.

E. C. Cornelius has been appointer assistant engineer on the Atlas Cement Company's steamer *Josh Cook* at New Orleans, La.

Harry J. Thompson has succeeded A. J. McMillan as chief engineer of the Associated Bar Pilot's tug *Jenny Wilson*, at Port Eads, La.

Floyd F. Woods has been appointed sales manager of the Epping-Carpenter Pump Company, Pittsburg, Pa., succeeding Mr. R. Bowen, resigned.

John F. Ward, formerly chief engineer of the steamer *Old Colony*, has accepted a position as engineer with the Illuminating Company at New Haven, Conn.

Sid. P. Terry, chief engineer of the Ohio River Steamboat *Johns Summers*, was off duty recently for several days on account of sickness. During his absence Samuel Shoemaker acted as chief engineer of the vessel.

Charles Delecroix has been appointed chief engineer of the Monongahela & Consolidated Coal Company's towboat *Finlay*. This boat recently left New Orleans, La., for Pittsburg, Pa., with a full tow of empty coal barges.

William Simonds, formerly chief engineer of the Louisiana Railroad & Navigation Company's transfer steamer *Lewis*, has been appointed chief engineer of the United States Navigation steamer *Ram*, at New Orleans, La.

A. S. Halligan has succeeded A. J. Taylor as chief engineer of the steamer *New Camilia*. The *New Camilia* has resumed her old trade on Lake Pontchartrain, replacing the new steamer *Hanover*, which will engage in the excursion business in the harbor of New Orleans until next spring.

William P. Lindley, chief engineer of the steamship *Lewis Luckenbach*, of the Luckenbach Steamship Company, has resigned his position with the company, the vacancy being filled by William G. Perow, formerly first assistant engineer of the steamship *Newport*, of the Pacific Mail Steamship Company.

Charles Johnson has resigned as chief engineer of the British steamer *Greenbrier*. This vessel has just been purchased by the United Fruit Company and is being fitted out to carry a full load of cotton from New Orleans to Bremen, Germany, at the rate of $17.50 (3/12/11) per bale. It is estimated that, if she arrives safely at Bremen, she will have paid for herself in this single voyage.

Captain E. A. Burnside, manager of transportation of the Campbell's Creek Coal Company, Point Pleasant, W. Va., had charge of the company's towboat *Eugene Dana Smith* on her first trip to Cincinnati, Ohio, after the low water which has prevailed through the season. In the keen competition with other boats taking advantage of this first rise of water, Captain Burnside brought his tow into Cincinnati ahead of any other vessel, an achievement that is readily appreciated by the Western river pilots, who are familiar with the hazards attending such a task.

George H. Highbee, vice-president and general manager of the Pacific Coast Steamship Company, has submitted his resignation, to take effect on January 1, on account of ill-health. Mr. Highbee was formerly associated with the firm of Peter Wright & Company, agents for the American and Red Star lines on the Atlantic coast. In 1898 he went to the Pacific coast as general manager of the Empire Line, but returned to New York to become identified with the International Mercantile Marine. In 1906 he again returned to the Pacific coast to take up the duties of president of the Moran Shipbuilding Company, Seattle, Wash., a position which he held until 1908, when he became associated with the Pacific Coast Steamship Company.

Naval Constructor David W. Taylor, U. S. N., received his appointment as chief constructor of the navy on December 14, and with it the rank of rear admiral. Rear Admiral Taylor is the senior naval constructor in the navy and formerly held the rank of captain. He was born in Philadelphia on March 4, 1864, and graduated from the naval academy in 1885 at the head of a class which was noted for the number of brainy men that composed it. He received a higher rating at the academy than has ever been given before or since that time. After a few months at sea following his graduation from the academy, he was ordered to England to take up the study of naval construction at the Royal Naval College, Greenwich. His standing at that institution paralleled his record at the United States Naval Academy. His work as a naval constructor for the twenty-eight years since his appointment has been conspicuous. In recent years he has been in charge of the work at the experimental model basin at the Washington Navy Yard, where his researches in hull design have been of inestimable value to the world. His published works, both in the form of papers read before the leading institutions of naval architects in the world and in books which have become classical, stand foremost in the literature on naval architecture. His position as the senior naval constructor, his official record, and his service and international reputation, all make him the natural selection as chief of the bureau of construction of the Navy Department.

Obituary

Colonel Edward Daniel Meier, president and chief engineer of the Heine Safety Boiler Company, and former president of the American Society of Mechanical Engineers, died in New York on December 15 at the age of seventy-four.

Charles A. Moore, president of Manning, Maxwell & Moore, Inc., New York, who sailed from New York on December 1, on the Holland-America steamship *Rotterdam*, for Naples, Italy, died from heart disease at sea. Early in 1862 Mr. Moore enlisted in the navy and served as a member of the crew of the *San Jacinto*. Soon after the war Mr. Moore entered the industrial field, and achieved a far-reaching success in the organization and direction of industrial companies. He was a man of wide interests, including both industrial, political and social. He was a director in many of the largest corporations in the country, and a valued member of many organizations and clubs. His age was sixty-eight years.

Rear Admiral Alfred Thayer Mahan (retired), noted as naval expert and writer, died in Washington, D. C., December 1, at the age of seventy-four. Mr. Mahan was graduated from the Naval Academy at Anapolis and promoted through the various grades until as a captain in 1896 he retired at his own request. During the Civil War he served on the ship *Congress* and on the south Atlantic blockading squadrons. Rear Admiral Mahan has served at various American naval stations throughout the world. He has been president of the Navy War College at Newport, and, during the Spanish War, was a highly valued member of the Naval Board of Strategy. In 1899 he was a delegate to the Hague Peace Conference. He is widely known throughout the world as the author of many authoritative works on naval history and sea power.

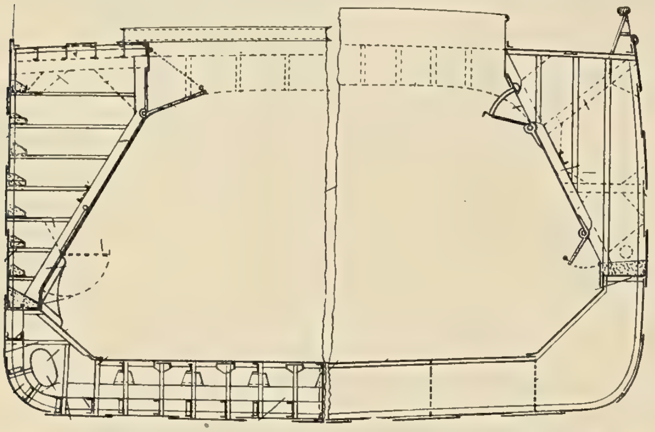
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,110,077. CONSTRUCTION OF SHIPS AND OTHER VESSELS. JOSEPH R. OLDHAM, OF CLEVELAND, OHIO.

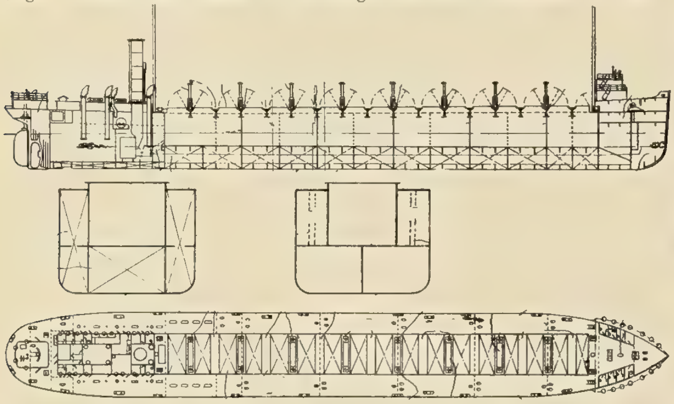
Claim 1.—In a steel bulk-cargo vessel having a water bottom with lower side tanks, longitudinal bulkheads extending diagonally inward from the top of the water ballast tanks at sides to the deck at the sides



of the hatchways, throughout the cargo holds, the upper part of said bulkheads being perforated to form chutes to admit bulk cargo into the side holds, with apertures at the lower part of said bulkheads to emit the cargo into the main holds, substantially as and for the purpose specified. Eleven claims.

1,111,740. ORE, BULK OR DENSE CARGO CARRIER. HUGO P. FREAR, OF SAN FRANCISCO, CAL., ASSIGNOR TO BETHLEHEM STEEL CORPORATION, OF SOUTH BETHLEHEM, PA., A CORPORATION OF NEW JERSEY.

Claim 1.—A vessel comprising an outer main shell, a longitudinally extending cargo hold arranged centrally within the main outer shell with its bottom wall elevated a substantial distance from the bottom wall of the main shell, closed side tanks arranged between the cargo hold and the side walls of the main shells and adapted for the reception of a liquid ballast or liquid cargo, and closed lower tanks arranged between the bottom of the cargo hold and the bottom of the



main outer shell and extending completely across the bottom of the cargo hold, said lower tanks being divided by a central closed bulkhead and having open communication to said side shells, and the combined capacity of said side tanks and lower tanks being greater than the capacity of said cargo hold, and means for introducing and withdrawing liquid ballast into each of the lower closed tanks. Seven claims.

1,112,138. SIGNAL-BUOY. HORACE H. HILL, OF SOMERVILLE, AND ROLLIN ABELL, OF BOSTON, MASS., ASSIGNORS TO SUBMARINE SIGNAL COMPANY OF BOSTON, MASS., A CORPORATION OF MAINE.

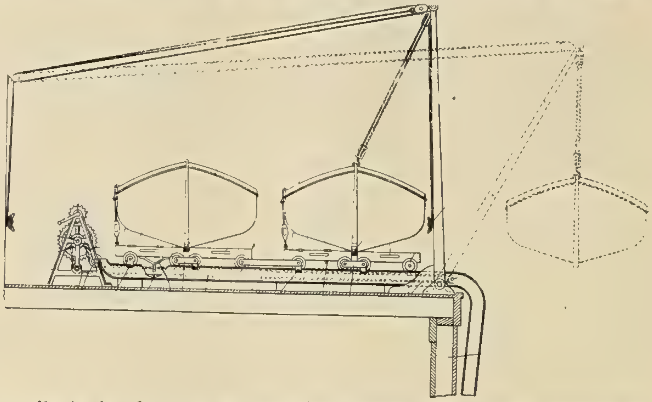
Claim 1.—In a signal-buoy, in combination, a signaling means, a pair of power-storing devices, means operable by wave motion, means for operatively connecting one of said power-storing devices to said wave operated means to cause power to be stored and for simultaneously causing the disconnection of the other of said devices from said wave operated means, and means for operatively connecting each of said devices with said signaling means when disconnected from said wave operated means. Eight claims.

1,118,499. APPARATUS FOR LAUNCHING LIFE-BOATS FROM DECKS OF SHIPS. SIMON LAKE, OF MILFORD, CONN.

Claim 8.—The combination with a ship, of a series of frames journaled on the side thereof in step-like order and extending from the boat-deck of the ship to the waterline, a horizontal boat-supporting member carried by each frame and having rollers mounted thereon, a transversely arranged track mounted on said boat-deck, forming extensions secured to the ends of the rails of said track and adapted to be extended transversely of the ship, a boat-carriage operable on said track, and a life-boat adapted to be rendered air and watertight carried by said carriage, said boat having longitudinal parallel skegs adapted to engage the rollers of said horizontal members of the frames when passing over said members. Fourteen claims.

1,111,836. LAUNCHING DEVICE. JOHN ALBERT JOHNSON AND JOSEPH W. LUDLAM, OF OAKLAND, CAL.

Claim 1.—A boat handling mechanism comprising in combination, a track mounted on the deck of a ship and extending from a point inboard to the edge of said deck and then down the side of the vessel for a substantial distance, said track being extended outward from the edge of the vessel at the level of the track and then bending in-



wardly in its downwardly extending portion, and a train mounted on said track, said train comprising a plurality of trucks pivotally linked together, and means for retaining said trucks on said tracks when they are lowered over the side of the vessel. Two claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

21,844/1913. IMPROVEMENTS IN ICE-BREAKING STEAMSHIPS. SIR W. G. ARMSTRONG, WHITWORTH & CO., LTD., AND E. L. ORDE, THE WALKER SHIPYARD, NEWCASTLE-ON-TYNE.

Where ice-breaking steamers are working in certain parts of the world, they sometimes meet a serious obstacle in the shape of spongy ice, known by the name of "frazil" or "lolly" ice, which is often found extending some 20 to 30 feet below the sheet of solid surface ice. A slight increase in temperature of the surrounding water is found sufficient to dissolve this "frazil" ice. According to the invention, the temperature of the surrounding water is raised by injecting steam or heated water into it by means of a special arrangement of steam heaters fitted in convenient parts of the bottom or sides of the ship. The heaters are similar to ordinary steam ejectors, and are provided with an inlet for the cold water from outside, an outlet for the heated water and a steam nozzle. These nozzles are supplied by steam pipes. The heaters are arranged in watertight compartments.

25,414/1913. IMPROVEMENTS IN ARRANGEMENTS FOR IMPELLING WATER THROUGH SHIPS' CONDENSERS. H. OECHSLIN, FLITWICK ROAD, AMPTHILL, BEDFORDSHIRE.

The object of the invention is to provide a substitute for the hitherto employed types of pumps within one of the pipe lines of the condenser, with a consequent saving of space and increase of efficiency of the circulation. Sea water is conducted by a pipe from an intake in the side of the ship to the condenser and discharged through a similar outlet; two or more axial-flow turbine pumps may be fitted to impel the water in series, either secured on the same or different shafts in the same pipe line, or in separate pipe lines.

26,229/1913. IMPROVEMENTS IN SLIDING WINDOWS AND DOORS FOR SHIPS. G. PATE CARRON CO., CARRON, STIRLINGSHIRE AND R. B. KINNIBURGH.

Claim.—The glass holder or sliding sash is provided with rack and teeth. Gearing with these racks are spur pinions centered loosely on studs secured in the frame of the window near the lower extremity of the sash. When it is in its highest or closed position, these pinions also gear with teeth formed on balance weights, which weights travel parallel to the sash but in the opposite direction thereto, so that as the sash is opened or lowered, the weights rise and *vice versa*. Both the sash and weights are provided with guide grooves or projections which engage corresponding groves on the fixed frame and curve flats.

21,007/1913. HEATING AND COOLING AND VENTILATION APPARATUS FOR THE USE IN SHIPS. W. N. HADEN AND OTHERS (TRADING AS G. N. HADEN AND SONS), ST. GEORGE'S WORKS, TROWBRIDGE, WILTSHIRE.

Claim.—Consists of apparatus for heating or cooling and ventilating compartments on ships wherein the air for each compartment passes through a series of tubes in some of which the air is heated and is then cooled, means being provided for causing the air to pass through the heaters or cooling tubes, as desired. The air may be heated by means of hot gases or water, and the air may be cooled by a cooling medium from a refrigerator.

1,320/1914. IMPROVEMENTS IN THE METHODS OF CEILING ORDINARY FLOORS IN SHIPS. J. MAC GREGOR, 56 BEDE BURN ROAD, JARROW-ON-TYNE.

Claim.—This invention relates to improvements in the methods of ceiling ordinary floors in ships, having for its principal objects such alterations as will dispense with wood ceiling on ordinary floors. In addition, this invention obviates the necessity of lifting the wood ceiling when liquid cargo is to be carried. Portable strakes of iron plating are fitted onto reverse bars, on the top of ordinary open floors, between fixed rider plates, which form the top members of the center and side keelsons, the rider plates being fitted flush with the top of the ordinary floors. The portable strakes are butted where double reverse bars are fitted and refastened to reverse bars by tap screws or other suitable means.

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Economy of Motor Ships

Some interesting figures regarding the relative economy of a steamship and a Diesel motor ship of about the same speeds on long voyages were given recently in a paper read by Mr. I. Knudsen, of Burmeister & Wain, before the Northern Merchants' Shipping meeting at Malmo. The deadweight capacity of the steamship was 8,720 tons, and of the motor ship 9,700 tons. The average speed of the vessels was in the neighborhood of 11 knots. Considering the item of fuel only, the relative costs of carrying 1,000 tons of cargo a distance of one mile at 11 knots on the steamship and on the motor ship showed a saving equivalent to 67 percent in favor of the motor ship. Other factors which might have an important bearing on the relative costs of operation, however, were not taken up in detail.

United States Coast Guard

It is gratifying to note the favorable action taken by both Houses of Congress on the bill creating a Coast Guard by combining the existing Life Saving and Revenue Cutter Services. Years ago both of these services were administered under one executive head, but lately, although both are devoted mainly to the saving of life and property from the ravages of the sea, they have been operated as distinct organizations. By combining the two, it is confidently expected that the efficiency of the Life Saving Service will be materially increased and a Naval Reserve of about 4,100 trained and highly efficient officers and men will be created which will be ready at a moment's notice to operate under the Navy Department whenever the President so directs. A retired list is provided for the men on account of age, or after thirty years' service, and the men of the Life Saving Service will receive longevity pay for re-enlistments. They will also have clothing allowances and medical attention from the Public Health Service. In lieu of a pension list for the dependents of those who lost their lives in the service, a sum of money equivalent to two years' pay is given. This measure does not in any way increase the number of employees of the government, neither does it raise the basic salaries of the men already employed, as all increases in pay are due to length of service only; nor does any commissioned officer of the Revenue Cutter Service receive an increase in pay or allowances on account of this change. It is very evident that this measure will be advantageous both to the government and to the men employed in these branches of the military forces of the government, and it is gratifying to know that all of this will be brought about at a maximum total increased cost of less than 8 percent of the present annual cost for the entire maintenance and operation of the two existing services.

Future French Battleships

Since the beginning of the war little has been said regarding the new battleships that the French Admiralty intended to build as soon as the vessels of the *Normandie* class were launched. The four battleships proposed were to be named the *Duquesne, Trouville, Lyon* and *Lille,* but, on account of the uncertainty of the war, it is quite impossible to state when these vessels will be laid down, or what changes may be made in their design. In spite of this, however, it is interesting to examine the main features of these vessels as originally proposed. The new battleships were to have a length of 624 feet and a normal displacement of 29,500 tons, as compared with the length of 574 feet and the displacement of 25,300 tons of the vessels of the *Normandie* class. The beam in both cases was the same, 88 feet 7 inches, although the draft at the stern of the new vessels was to have been 29 feet 10 inches as against 29 feet in the previous class. The new battleships were designed for a speed of 23 knots, for which it was estimated a brake horsepower of 42,000 would be required as against 32,000 brake horsepower in the older ships, which have a speed of only 21 knots. The armament of the *Duquesne* was to consist of sixteen 13-inch guns arranged in four 4-gun turrets of the same type as on the *Normandie,* although the probable arrangement of the turrets would be in accordance with the arrangement on the United States battleship *Michigan,* with a possibility, however, that turret No. 3 would be placed amidships, as on the *Normandie.* The 13-inch guns were to be of an improved design which is claimed to be as powerful as the 14-inch guns used by other naval powers. The turrets were to be hydraulically operated with the Janney patent gear. The secondary battery was to consist of twenty-four 5.5-inch guns, also of an improved

design superior to the rapid fire guns on the *Normandie*. In general, the armor on the new vessels was to have been of greater thickness than the armor on the *Normandie,* which was 14.5 inches thick at the waterline. The whole protection of the *Duquesne* was to have been more extensive than on the *Normandie*. The propelling machinery was to be of the combination type, arranged on four shafts with the high-pressure reciprocating engines on the center shafts and low-pressure turbines on the wing shafts. This arrangement has been widely adopted on large French liners, and is in general considered to be the most efficient arrangement of machinery that could be adopted for this type of vessel. Although the above designs are wholly tentative and may be considerably modified, if the ships are finally laid down, they are nevertheless of considerable interest in view of the latest battleship designs developed for the other naval powers.

Surprising Failure of Steel Ship Plates

Considering the treatment which ship plates must undergo, both in the shipyard while being flanged and riveted, and afterwards in the ship in service when the plates are subjected to unknown stresses, the necessity for a method of testing the steel of which the plates are made to determine its suitability for the purpose is of the utmost importance. Lloyd's Rules for testing shipbuilding materials are generally regarded as reliable, and steel which is passed by Lloyd's surveyors is generally accepted as suitable for the purposes intended without further investigation. A case is cited, however, by Mr. W. J. B. Wilson in a paper recently read before the North East Coast Institution of Engineers and Shipbuilders, in which a consignment of steel ship plates, after passing Lloyd's tests and being characterized by the surveyor as "excellent," failed in a surprising manner shortly after being worked into the ship.

In this case the shipbuilding firm received an order for an ice-breaking passenger and cargo steamer to be built to Lloyd's highest class under special survey. The vessel was begun in November, 1907, but, owing to delay in obtaining the material, the shell plating was not begun until the end of December. B strake was first worked, but, owing to the difficulty with the flanging of the garboard strake plates, several of which cracked, the rest of the shell was practically completed before the garboard strakes were put in place.

The garboard strake plates which cracked were carefully examined, but as the results of both bending and tensile tests were excellent, the failure at the time was ascribed to the severe cold weather prevailing, the temperature being from —13 to —18.4 degrees Fahrenheit.

The riveting of the shell was well under way before the keel riveting was begun, but, after a few garboard plates had been riveted, cracks were noticed between the rivets and the edge of the plate in the flanged portion. These plates were condemned by the Lloyd's surveyors and were cut out. During the process two of them cracked badly in the neighborhood of the keel rivets, and the astonishing fact developed that a single blow with an ordinary hand hammer was sufficient to knock pieces out of the flanged portion.

This sudden change in these plates, which had withstood flanging, punching, riveting, and, in some cases, calking, was very remarkable and the job of riveting the keel was at once stopped until a thorough hammer test of the flanged portion of all the remaining garboard plates had been made. When this proved perfectly satisfactory, the riveting was resumed and only one or two small cracks developed.

About this time severe cold weather set in again, and on January 11, 1908, one of the garboard plates, which had been riveted in the ship for a period of three weeks, was found to be badly cracked. The crack started from a rivet hole in the flanged portion and went off into the plate in a transverse direction, being about 10 inches long and about 3/32 inch open at the widest part. This was clearly a case of spontaneous rupture.

When this plate was cut out the material in way of the keel rivets cracked in the same way as that described above, and a new hammer test was made with startlingly different results from the previous one, as every plate in the garboard strakes, with the exception of those previously replaced, cracked and in some cases pieces fell out. These plates were, therefore, condemned and cut out.

So far the cracks had been entirely confined to the flanged portion of the garboard strakes, but during the cutting out of the rivets connecting the garboard plates to B strake several plates in B strake also cracked. A new survey was then made by Lloyd's and pieces cut from the plates in the ship rolled from different charges were tested. All of the tests proved satisfactory to the surveyor, but after these tests the astonishing fact developed that one blow of a heavy hammer was sufficient to knock large pieces out of flanged portions of the shell plates. The net result of this survey was that all plates rolled from the same charge as the garboard strakes, together with several plates which had bad surface defects, were condemned. The latter had been filled with some composition which fell away during riveting. One plate had two large holes which had been filled up. A 6-inch feeler pushed into these holes penetrated 1½ inches, while the makers' brand was not 12 inches away on the same side of the plate.

The condemned plates, twelve in number, were in various strakes of the shell plating, and during the removal, in spite of the care taken, the trouble spread over the whole of the bottom of the vessel. As an example, one of the plates in E strake, ½ inch thick, which had been punched, sheared, bent, riveted and calked without any trouble, had to have the rivets in its lower edge removed in order to take out a plate in D strake. When the rivets were center-punched preparatory to drilling them out, the plate in E strake cracked, although it was not actually touched by the hammer, which was only an ordinary hand

hammer. In the edge of this plate, when all the rivets had been drilled out and driven, sixteen cracks were found.

This plate was afterwards examined by Lloyd's surveyors, when it was plainly shown that one blow with a sledge hammer was sufficient to cause cracks to appear between the edge and butt rivet holes; but, although the hammering was continued, not a single crack would travel far into the plate away from the rivet holes. The failure still continuing, a new survey was made by two of Lloyd's surveyors, one of whom had previously tested the steel. Tests were made, but these, like all the others, failed to throw the slightest light on what was really wrong with the steel. The treatment of the steel was criticised, but it was subsequently established that the workmanship in the shipyard was above reproach.

After these tests had been made, the surveyors maintained that as the steel passed the tests laid down in the rules, they were not justified in blaming the material unless a test could be devised which would in their presence prove the steel to be at fault. Meanwhile, the author of the paper, who had made scores of tests with this object in view, had found one that gave the required results, and which may prove useful to others in like circumstances.

This test consisted of placing a butt strap which had not been worked into the vessel and a plate of material made in a Swedish steel works in a mixture of snow and salt, which reduced the temperature of the plates to —4 degrees Fahrenheit. The plates were then quickly punched on one side for double riveting and riveted together, care being taken that the edges of the plates opposite the holes were kept cool with ice in order to represent as closely as possible the conditions when working the steel in a low temperature. After the plates were allowed to cool down, the rivets were driven out, during which operation the plate from the butt strap cracked badly and a piece fell out. The plate from the Swedish steel works, however, did not show the least signs of cracks.

From another plate two strips 2⅜ inches wide were cut and four holes ⅝-inch diameter and 4½ diameters apart were punched and the strips riveted together. The same was done with two similar strips, but with drilled holes, the temperature at the time being about 39.2 degrees Fahrenheit. After cooling, the strips were bent through an angle of 25 degrees and the outer strip was found to be broken right through in the punched sample and cracks were found in the drilled sample.

These butt strap tests were sufficient to convince all concerned that the material was really entirely spoiled by riveting, and therefore the builders were relieved from all blame, the workmanship being characterized as "first class." A further proof that the material was bad was the very conclusive one of the new Swedish material, which, although worked in the same way, gave no trouble at all.

From the foregoing, it is evident that the ordinary methods of testing in this particular case were insufficient to detect the poor quality of the material which was being used, and dependence upon such tests under like conditions certainly seems to place shipbuilders and others in a position in which they run grave risks. The test made by Mr. Wilson in which a mixture of snow and salt was used certainly detected the fault in this particular steel, and is therefore worthy of consideration. Subsequent tests of samples of this steel made by Professor J. O. Arnold of the University of Sheffield, showed that from a chemical point of view the steel was not of very good quality, and that it appeared to have been overheated in the manufacture and gravely injured by the operation.

Electricity on Board Ship

Light, heat and power are the three main classifications under which electricity is used on board ship, but in no type of vessel is electricity put to more varied uses than on a modern battleship. On the Argentine superdreadnought *Moreno*, for instance, which is of 27,566 tons displacement, the electrical generating plant consists of four 375-kilowatt turbo generators of the horizontal type, while in addition there are two Diesel oil engine-driven generators of 75-kilowatt capacity each, for harbor use when the fires are drawn. The electrical equipment on this vessel is the largest and most costly ever installed in the United States, and comprises 3,000 electric lights, 4,000 rated horsepower of motors and approximately 76 miles of cable. Several other features aside from the size of the plant are noteworthy in that a voltage of 230 is used, which is a departure from ordinary American marine practice. These features include the employment of lead-covered steel armored conductors, the application of 220-volt Tungsten lamps, the use of electricity for steering the vessel, operating the anchors and bilge pumps, for turret turning, gun elevating and many other purposes, so that the equipment stands as a valuable working comparison with previous installations.

On the large transatlantic liners, the application of electricity is no less striking; for instance, on the *Aquitania*, where the generating plant consists of four 400-kilowatt, 225-volt continuous current turbo generators, there is a total of 200 motors aggregating 2,590 horsepower, in addition to nearly 10,000 lamps supplied with current at 110 volts. Similarly on the *Mauretania*, independent of the power for lighting, there is a total of 2,133 horsepower of motors; all of which goes to show the rapidly increased application of electricity on board ship. In considering the question of lighting on board ship, where savings of space and weight are of much importance, the use of Tungsten lamps offers several distinct advantages. Tungsten filament lamps consume approximately 1.10 watts per candle-power as against 3.10 to 3.50 watts by carbon filament lamps, which, reduced to a practical basis, means that by using Tungsten lamps smaller and lighter generating apparatus, lighter wiring and less coal storage space are necessary on the ship.

Self-Unloading Freight Steamer Huron

Unusual Type of Lake Freighter Fitted with Discharge Boom and Conveyors for Unloading Bulk Freight—Trial Data

One of the most interesting vessels built on the Great Lakes last year was the self-unloading bulk freight carrier *Huron*, constructed at the Great Lakes Engineering Works, Detroit, Mich., for the Wyandotte Transportation Company, Wyandotte, Mich. The vessel was launched February 7, 1914, and completed April 22, 1914. Its length over all is 439 feet 3 inches and on keel 416 feet. The molded beam is 56 feet and the molded depth 30 feet.

The general arrangement of the vessel is similar to practically all bulk freighters, the machinery being aft and the pilot house and "texas" forward on the forecastle deck, with the quarters for officers and crew in the deckhouse aft and in the forecastle and "texas" forward. There are in all 21 hatches and the net cargo capacity at 19 feet draft is 8,000 tons of stone and on about 16 feet draft 6,000 tons of coal. The water ballast capacity is 5,200 tons, and the machinery installed is designed to give the vessel a speed of 12 miles per hour.

The cargo space is arranged in two long hoppers running practically the full length of the hold, the slope of the hoppers being about 35 degrees. The water bottom is 3 feet 6 inches deep for a width of 31 feet. On each side of this the side tanks are carried up to the slope of the hopper. Along the centerline of each of the fore-and-aft hoppers are 32 gates, spaced generally 7½ feet between centers. These gates are of the hinged type and each one is operated by a large hand wheel with shaft and chains, as shown in Figs. 8 and 9.

Directly under the center of each of the hoppers and just above the water bottom is a 42-inch pan conveyor running the full length of the hold, and rising at the forward end to discharge into a cross chute, which delivers the cargo from both the fore-and-aft conveyors to a 72-inch pan conveyor on the centerline. This centerline conveyor carries the stone up above the spar deck and discharges onto a 48-inch belt conveyor, which delivers the stone over either side of the ship.

This belt conveyor has a length of 100 feet between centers and is carried on a truss, which is divided at the forward end and arranged so that it can be lifted to an angle of 20 degrees and swung outboard to an angle of 90 degrees with the ship on either side. The maximum reach of the discharge conveyor is 67 feet from the side

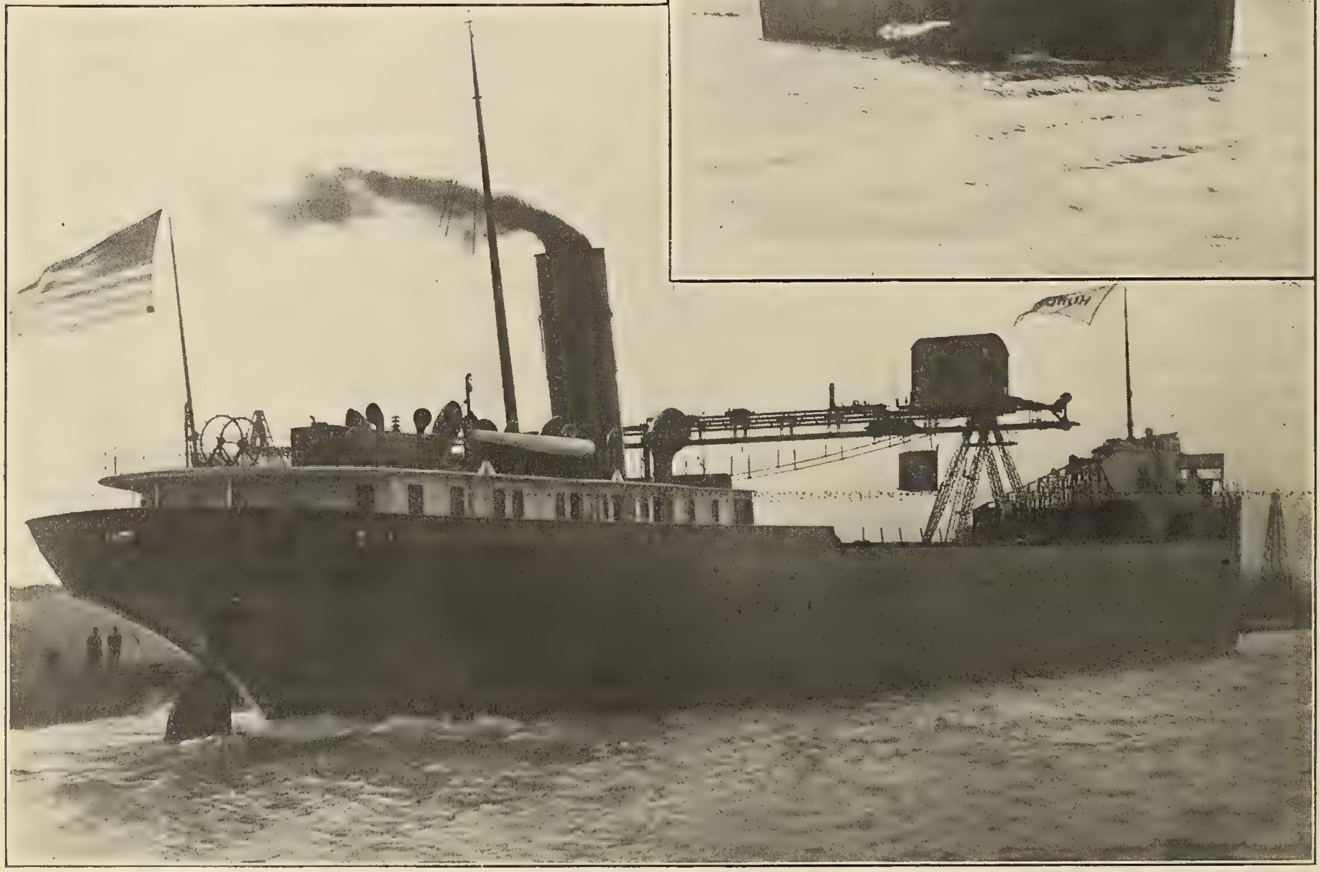


Fig. 1.—S. S. *Huron* at the Michigan Alkali Company's Dock

Fig. 2.—Bow View of the Vessel

of the ship and 52½ feet above the waterline, but, by the use of a short steel chute at the upper end of the boom, the stone can be thrown several feet farther from the ship than the actual reach of the belt.

Conveying Machinery

The conveyors are driven by two 150-horsepower reciprocating steam engines located on the spar deck in the forecastle. Ordinarily, one of these engines drives the two horizontal conveyors, while the other one drives the central inclined conveyor and the belt conveyor in the discharge boom. This same engine also drives the drum which raises and lowers the boom. The two engines are

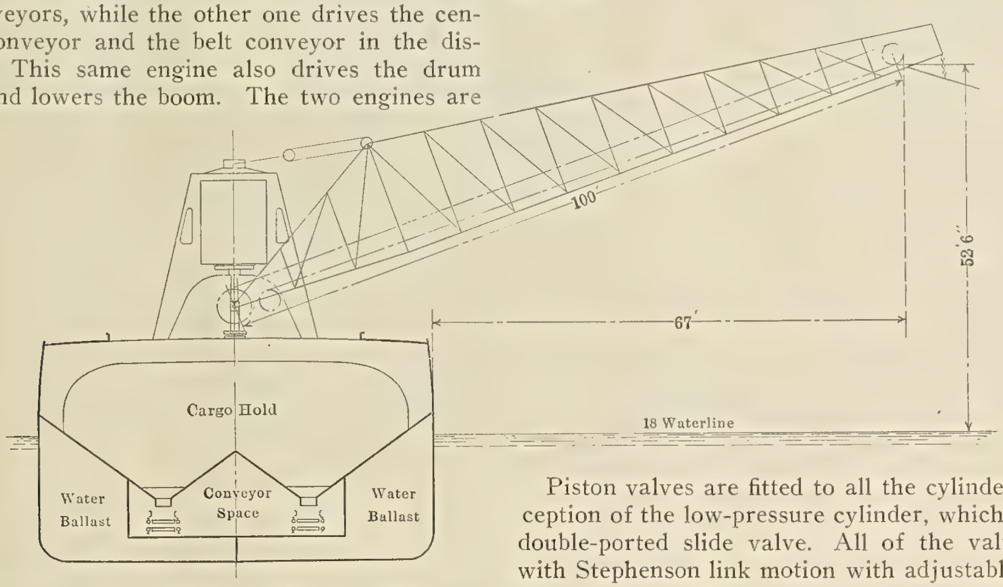


Fig. 3.—Cross-Section Showing Unloading Boom in Outboard Position

arranged with a connecting belt and clutches, so that in case of necessity either engine can be used to drive any part of the machinery.

The conveying machinery is all controlled by levers on the spar deck, just aft of the forecastle, so that the operator has a full view of the discharge boom and therefore has complete control of its movements.

Propelling Machinery

The main engine of the *Huron,* as stated before, is located aft. It is a vertical quadruple expansion engine with cylinders 19½ inches, 28¼ inches, 41 inches and 60 inches diameter with a common stroke of 42 inches. The designed indicated horsepower at 85 revolutions per minute and 35 pounds mean effective pressure is 1,770, while the maximum horsepower will run well over 2,000 with an increase in the revolutions to approximately 93 per minute. The usual arrangement of cylinders has been followed in this engine, and the sequence from forward to aft is high-pressure, low-pressure, second intermediate-pressure and first intermediate-pressure. The crank sequence is high-pressure, first intermediate, low-pressure and second intermediate-pressure. The question of balance of moving parts has been given very careful attention, with results which have proved highly satisfactory in service.

Piston valves are fitted to all the cylinders with the exception of the low-pressure cylinder, which is fitted with a double-ported slide valve. All of the valves are driven with Stephenson link motion with adjustable cutoff on the reverse arms. The high-pressure valve is 13 inches diameter; the first intermediate, 16 inches diameter, and the second intermediate, 21 inches diameter. All of these piston valves have a travel of 5½ inches. The low-pressure double-ported slide valve has ports 49 inches wide, while the travel is 7 inches.

All of the pistons are of cast-iron box section, the high-pressure having a removable solid follower ring with water grooves. The first and second intermediate pistons have removable follower plates and adjustable bull rings to allow for wear, while the low-pressure piston has packing rings with spring adjustment. In order to facilitate the balancing of the engine, the high-pressure and second intermediate pistons are heavy castings.

The piston rods are of open-hearth steel 4⅞ inches diameter in body, secured to the pistons with a taper fit and a 3¾-inch nut and to the crossheads with a taper key. The crossheads are of cast steel fitted with removable brass shoes on both ahead and astern faces: the crosshead pins are machine steel 5¾ inches diameter and 7¾ inches

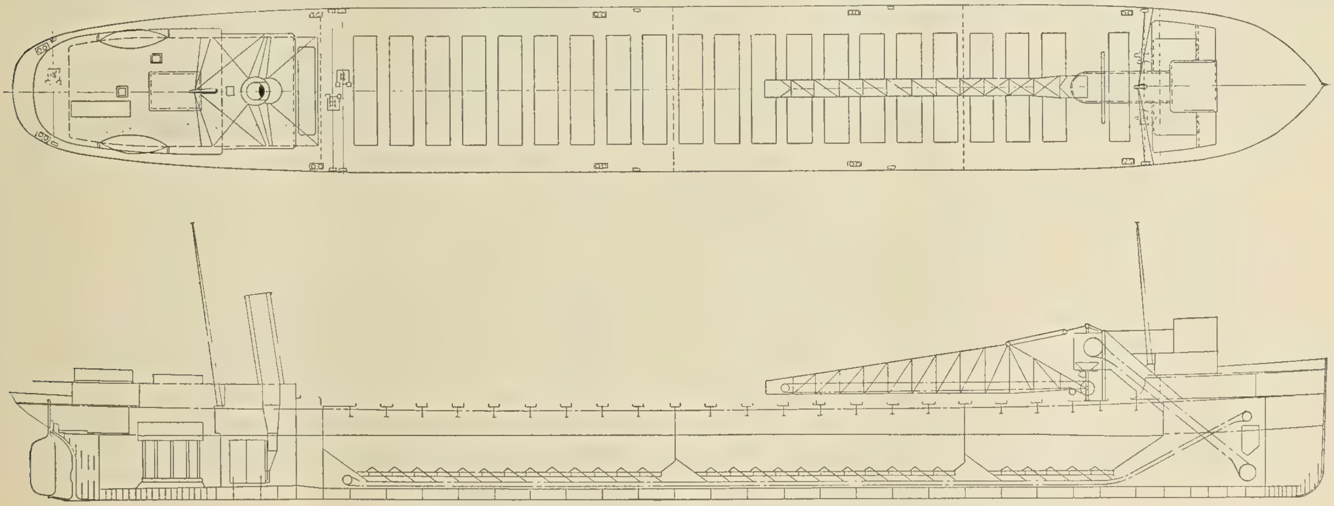
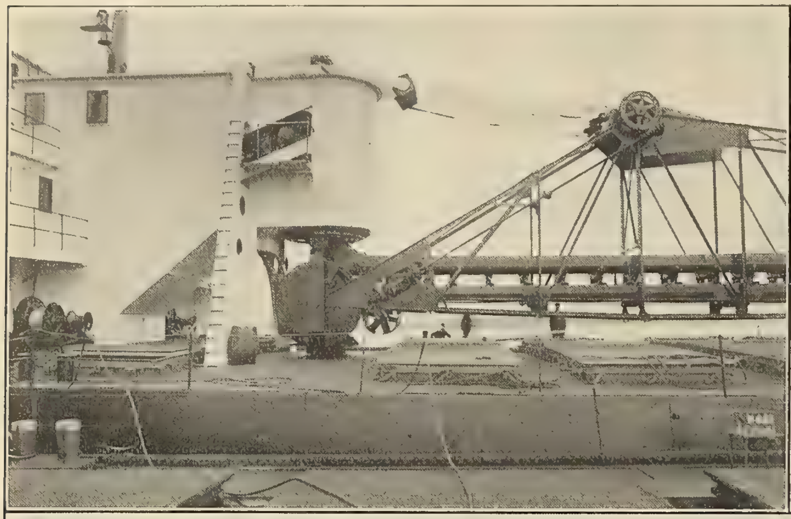


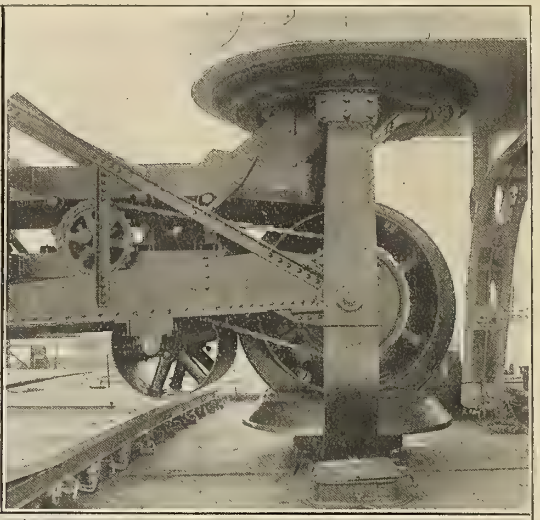
Fig. 4.—Deck Plan and Profile, Showing Arrangement of Conveyors on the *Huron*

long taper fitted to the crossheads for each piston rod.

The connecting rods are of open-hearth steel 8 feet 6 inches in length, center to center, with brass top end boxes adjustable for wear by means of a block and fore-and-aft taper wedge. The crank-pin boxes are of cast steel Babbitt-lined and are secured to the T ends of the connecting rods with annealed steel bolts 2½ inches diameter in the body and 2¾-inch thread. The body of the connecting rod is 4¾ inches diameter at the top and 5¾ inches at the bottom.

The crank shaft is of open-hearth steel of the built-up type with cast steel slabs securely shrunk and pinned to the shaft. Near the center a coupling is fitted with one-half forged on the after section and the other half formed in the cast-steel crank slab. The forward high-pressure and after first intermediate slabs have balance weights cast with the crank slabs. The diameter of the crank shaft and of the crank pins is 12 inches and the length of the crank pins 11 inches. The shaft is supported in five journals, three of which are 18 inches long, and two 14 inches long, all lined with Babbitt and having semi-steel caps secured with binder bolts 3¼ inches diameter.





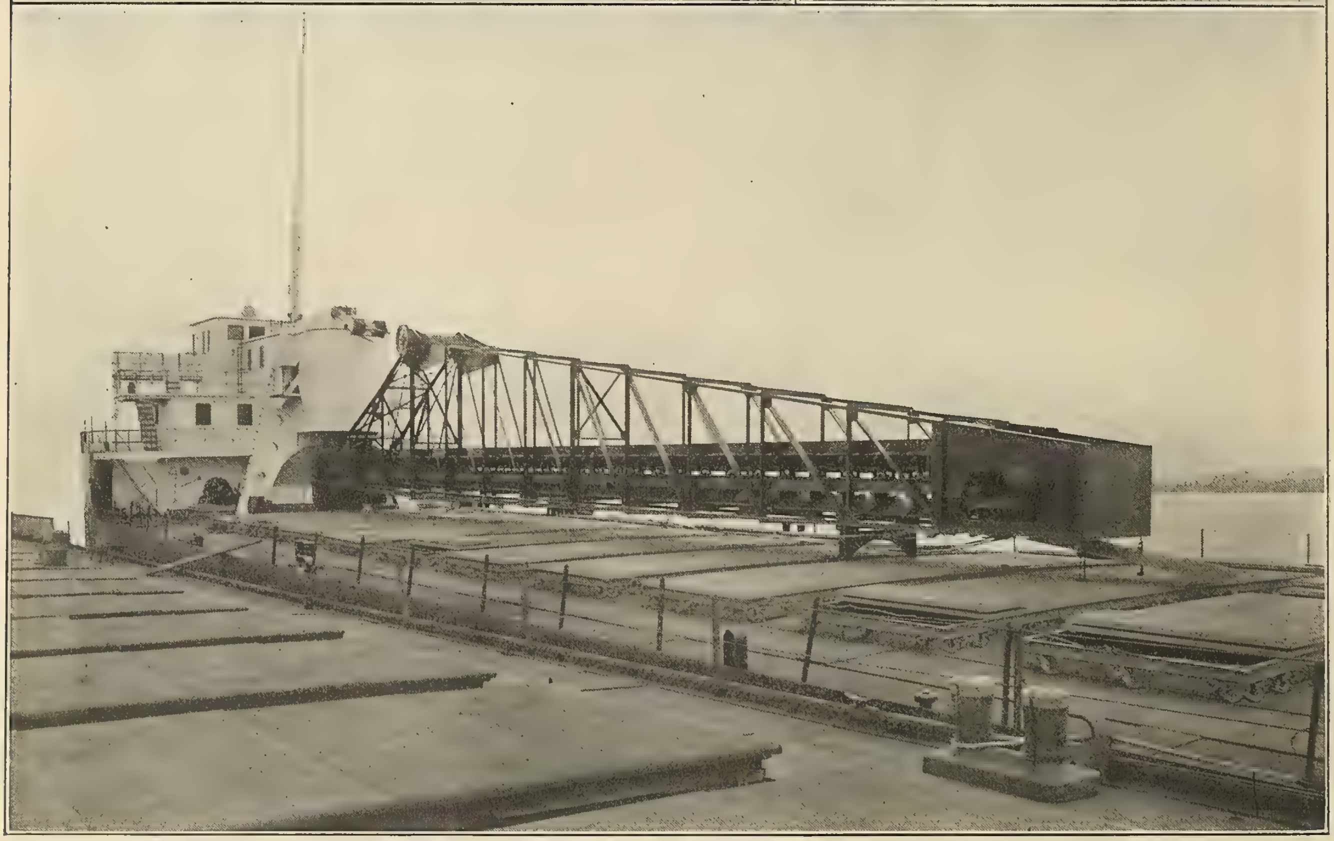


Fig. 5.—Upper End of Casing of Central Conveyor and Inboard End of Discharge Boom, Showing Method of Pivoting Discharge Boom and Blocking and Tackles for Elevating Boom

Fig. 6.—Inboard End of Discharge Belt and Boom, Showing Large Forging on Which Boom is Pivoted

Fig. 7.—View of Deck, Showing Discharge Boom and Forward House

The thrust shaft is also of open-hearth steel 12 inches diameter with the thrust collars forged on. The tail shaft is of the same material 12½ inches diameter in the body and 13¾ inches in the bearing, which is 4 feet 6 inches long fitted with lignum vita and Babbitt strips. The thrust block of cast iron has cast iron shoes faced with Babbitt on both faces and adjustable for wear. There are five collars, making the unit thrust pressure about 47 pounds per square inch.

The bedplate and both the front and guide columns of

Fig. 8.—View on Tank Top under Hoppers Looking Forward, Showing After End of Starboard Conveyor

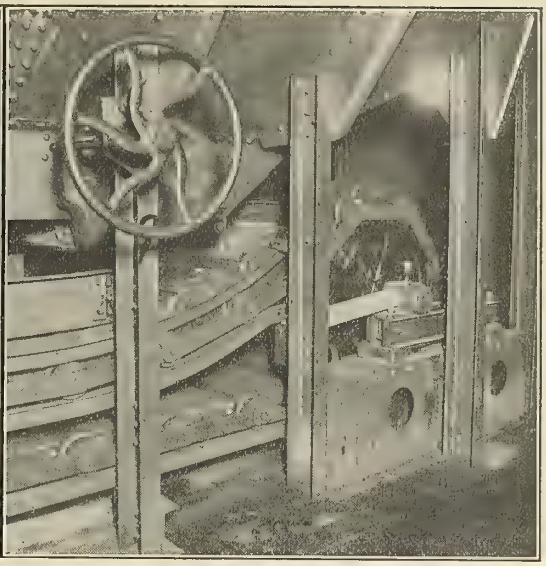


Fig. 9.—After End of Starboard Conveyor, Showing One of the Gates and Hand Wheel that Operates It

the engine are of cast iron of box section, all securely bolted at their various points of connection. Reversing of the engine is accomplished with a direct-acting steam cylinder 10 inches bore and 24 inches stroke, and provision is made for both reversing and turning the engine by hand.

The propeller is of the sectional type with four blades. Both the hub and blades are of cast iron with machine-steel stubs and brass ends. The diameter of the propeller is 14 feet 6 inches; the pitch, 13 feet 3 inches at the tip and 12 feet 1 inch at the hub, with a total developed area of 75 square feet.

Boilers

Steam is supplied at a pressure of 215 pounds per square inch by two Scotch boilers, 14 feet 9 inches mean diameter and 12 feet long over all. Each boiler has three corrugated furnaces, 44 inches inside diameter, leading to separate combustion chambers. The total heating surface in the two boilers is 5,192 square feet and the total grate surface 110 square feet, making a ratio of heating surface to grate area of 47 to 1. The heating surface in each boiler is divided as follows:

Tubes	2,211 square feet
Furnaces	140 square feet
Combustion chambers	245 square feet
Total	2,596 square feet

The draft area through the tubes is 13.28 square feet, making a ratio of grate surface to draft area of 4.14 to 1.

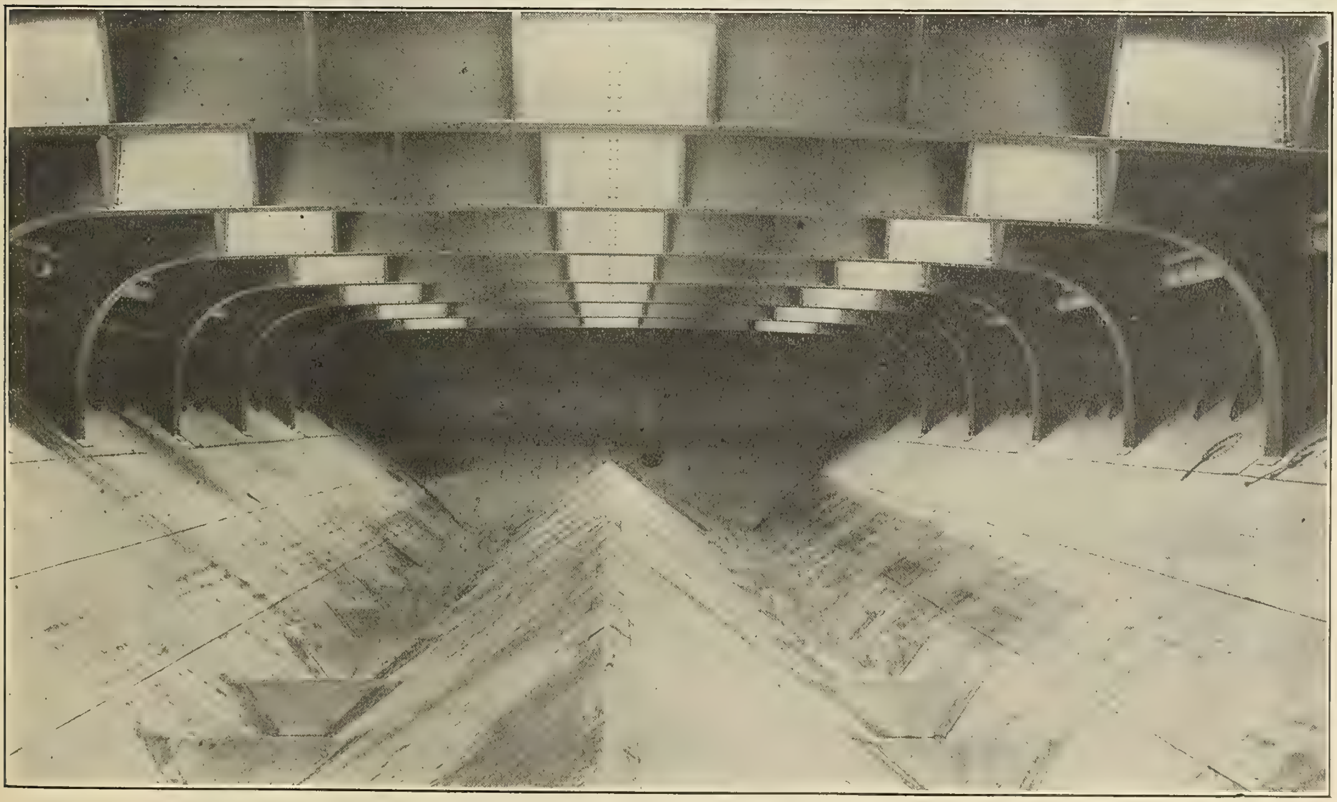


Fig. 10.—Inside of No. 3 Hold Looking Aft, Showing Fore-And-Aft Hoppers and Also Small Cross Hoppers

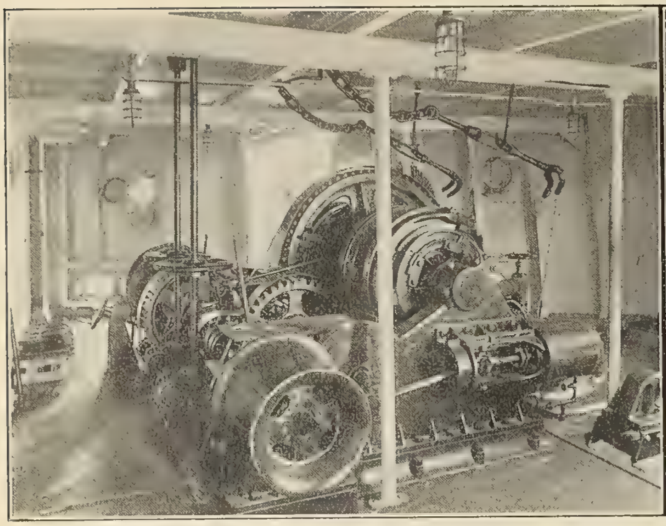


Fig. 11.—Windlass and Windlass Room

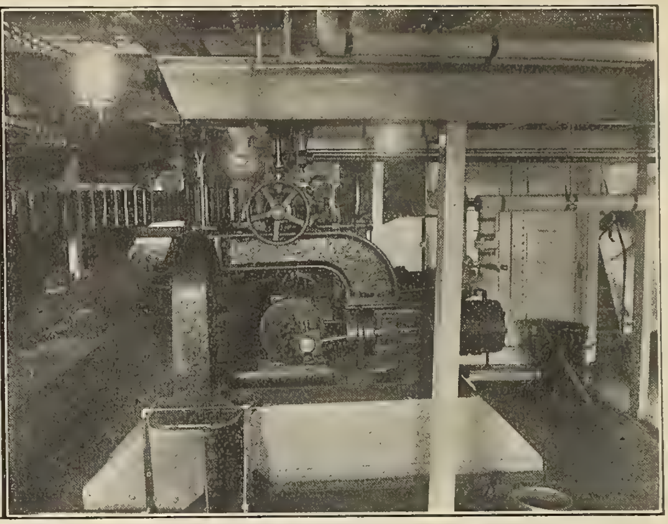


Fig. 12.—Steering Engine and Part of Quadrant

The boilers work under a system of positive heated draft, the air being conducted to the furnaces through a system of ducts.

The main steam stop valves are 6 inches diameter, and the main steam pipe 7 inches diameter. The auxiliary stop valves are each 5 inches diameter, supplying steam for all purposes, including also the unloading machinery forward.

The safety valves are 5 inches diameter, the feed valves 2 inches diameter, the main feed valves from the purifiers are 4½ inches, the main blow-off 2½ inches and the surface blow-off 1½ inches in diameter, respectively.

Auxiliaries

All of the pumps in this vessel are independent of the main engine with the exception of the air, bilge and water-service pumps. The attached air pump is of the double-acting type driven from the low-pressure crosshead with a beam and connections. It is 24 inches diameter with a

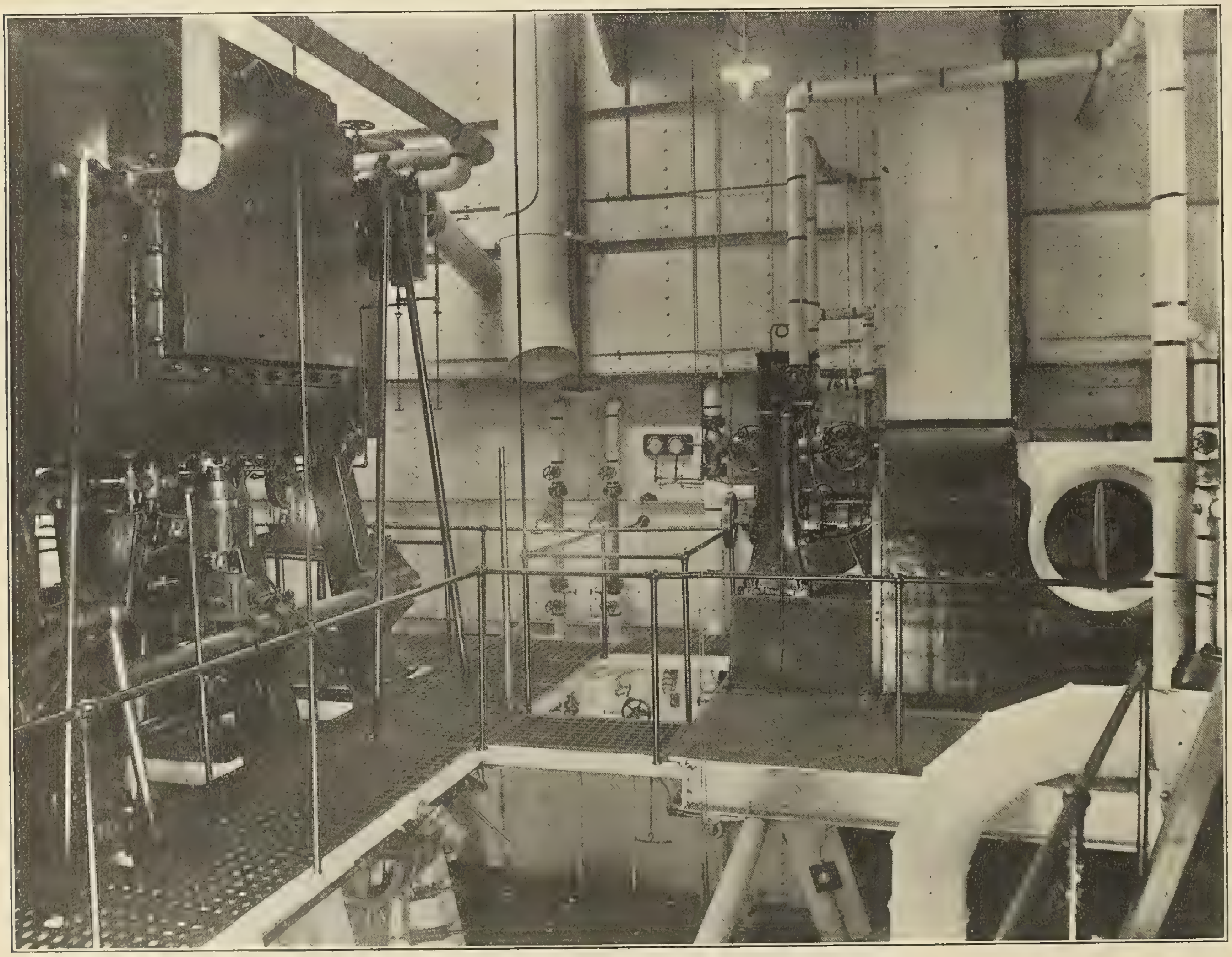


Fig. 13.—Starboard Side of Engine Room, Looking Forward at the Level of the Upper Grating

stroke of 14 inches. The bilge pump, driven from the same beam, is single-acting, 5 inches diameter and 12 inches stroke, while the water-service pump is also single-acting, 3½ inches diameter and 12 inches stroke.

The other pumps include a main feed pump 12 inches by 7 inches by 12 inches simplex double-acting; auxiliary feed and general service pump 10 inches by 6 inches by 10 inches duplex double-acting; one mate's pump 6 inches by 4 inches by 6 inches duplex double-acting; one sanitary pump 4 inches by 2¾ inches by 4 inches duplex double-acting; one 12-inch centrifugal ballast pump, and two 12 inches by 16 inches by 18 inches duplex double-acting ballast pumps.

For handling the exhaust steam from the unloading machinery, an auxiliary jet condenser is installed, together with a horizontal simplex air pump 8 inches by 12 inches by 12 inches.

For supplying air for the heated forced-draft system a fan is fitted driven direct by a single-cylinder 6-inch by 6-inch engine.

One horizontal tubular feed water heater takes care of the boiler feed at all times and two vertical purifiers 42 inches diameter by 8 feet long are installed for the purification of feed water.

Current for all electrical requirements is supplied by two 15-kilowatt generators direct-driven by 7-inch by 7-inch single engines.

Trial Trip

On July 2, 1914, a trial trip of the *Huron* was made between Sanilac and Sturgen Point, the draft of the vessel at the time being 18 feet 6 inches forward and 19 feet 6 inches aft. The vessel was loaded with 4,660 net tons, including fuel. The test lasted from 5:37 P. M. to 11:37 P. M.; the coal was weighed from 5:30 P. M. to 11:33 P. M., and indicator cards were taken every hour. The following table gives the average data taken on this run:

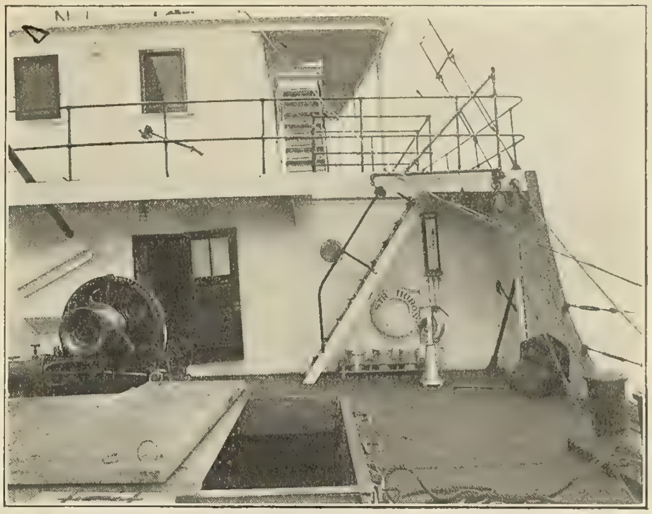


Fig. 15.—View of Deck Looking Forward, Showing After End of Forecastle and Texas on Starboard Side. McNab Draft Gage, with Deep-Sounding Machine just Below It, Can be Seen Directly under the Stairs to the Forecastle Deck

TABLE OF TRIAL DATA

Boiler pressure, pounds per square inch	208
First intermediate receiver pressure, pounds per square inch	86.4
Second intermediate receiver pressure, pounds per square inch	37.5
Low-pressure receiver pressure, pounds per square inch	9.1
Vacuum, inches of mercury	21.2
Revolutions per minute, average	84.9
Piston speed, feet per minute	594.3
Mean effective pressure, high-pressure cylinder	81.7
Mean effective pressure, first intermediate-pressure cylinder	36.
Mean effective pressure, second intermediate-pressure cylinder	14.97
Mean effective pressure, low-pressure cylinder	10.38
Mean effective pressure, referred to low-pressure cylinder	34.
Indicated horsepower, high-pressure cylinder	440.
Indicated horsepower, first intermediate-pressure cylinder	406.
Indicated horsepower, second intermediate-pressure cylinder	356.
Indicated horsepower, low-pressure cylinder	529.
Total indicated horsepower	1,731.
Generator horsepower equal 23 at main engine water consumption.	
Total horsepower plus generator allowance	1,754.
Ratio indicated horsepower to grate area	16.
Ratio heating surface to indicated horsepower	2.9
Temperature of injection water, deg. F.	56.

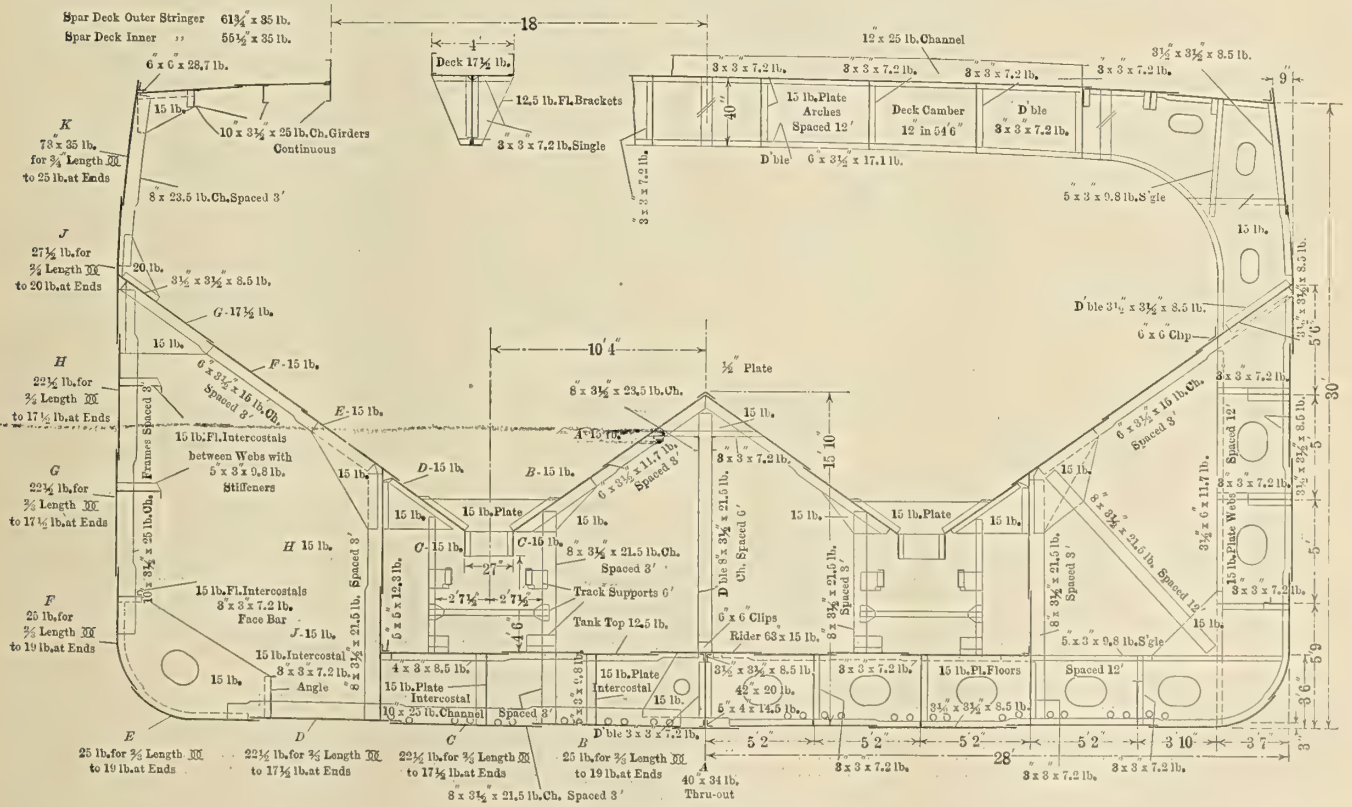


Fig. 14.—Midship Section

Temperature of stack, deg. F.	425.
Temperature of air casing, deg. F.	235.
Temperature of ash pit, deg. F.	250.
Temperature of fan intake, deg. F.	76.
Temperature of hot well, deg. F.	129.
Temperature of feed water, deg. F.	178.
Draft at fan, inches of water	1.57
Draft at air casing, inches of water	.7
Draft at ash pit, inches of water	.55
Revolutions of fan	463.
Kind of coal	Fair, ½-lump
Coal consumption, total 6 hours 3 minutes (as fired), pounds	16,050.
Coal consumption per hour (as fired), pounds	2,652.
Coal consumption per hour per I. H. P. (as fired), pounds	1.51
Reduction for British thermal units, percent	7.97
Reduction for moisture in coal, percent	8.37
Unburned coal in ash (6 hours 3 minutes), pounds	777.
Actual coal total (6 hours 3 minutes), pounds	12,643.
Actual coal per hour, pounds	2,090.
Actual coal per hour per I. H. P., pounds	1.19
Actual coal per hour per square foot grate, pounds	19.
Ash, total (as weighed), pounds	2,482.
Ash, total (actual), pounds	1,705.
Ash, percent (as fired)	15.4
Speed of ship, miles per hour	11.89
Distance, Port Sanilac to Sturgen Point, miles	98½
Time of run	8 hours 17 minutes
Slip of propeller, percent	4.
Admiralty coefficient	304.
Weather	fair, light head wind

Shipbuilding in the United Kingdom in 1914.—According to figures published in *Engineering*, the total number of merchant ships launched in the United Kingdom in 1914 was 1,129, making up a gross tonnage of 1,737,700 tons. This is 305,000 tons less than in 1913, which was a record year, and 173,835 tons less than in 1912. The total horsepower of machinery for merchant vessels built during the year was 1,473,300. It is interesting to note that 99.85 percent of the merchant tonnage built was steam tonnage, which is about the average for several years past. These figures by no means indicate the state of activity in the English shipyards and engine building works at the present time, as on account of the war conditions the figures for warship construction were withheld, and many of the largest establishments are devoting practically their entire facilities to this work. High speed vessels did not predominate in the year's production, although a number of notably large vessels were launched. The leading place among the shipbuilders fell to Harland & Wolff, Ltd., Belfast, both for the production of the largest tonnage of merchant vessels and also for the largest output of marine machinery. The largest vessel launched during the year was the White Star liner *Britannic,* of 50,000 tons and 60,000 indicated horsepower, built by Harland & Wolff, who also launched the Holland-America steamship *Statendam,* of 33,000 tons and 20,300 horsepower, and the Red Star liner *Belgenland,* of 27,000 tons and 18,400 horsepower. Among the features noted in the year's production were the increasing adoption of the Isherwood system of longitudinal framing and the increasing favor of geared turbines. Two large ships, the *Transylvania* and *Tuscania,* were fitted with this form of propulsion. A third ship, practically a sister ship to the others, is also being fitted with geared turbine drive, but with this difference, superheated steam will be used instead of saturated steam, as was the case in the other vessels. At the present time there are over twenty vessels being fitted with geared turbine drive, including practically every type of ship from the cargo carrier to large passenger vessels, so that this system of propulsion has much to commend itself. Harland & Wolff, however, continue to place reliance on the combination system which they have long advocated. As regards the internal combustion engines of the Diesel type, the firm that has done the most is the Burmeister & Wain Oil Engine Company, of Glasgow, which is associated with Harland & Wolff. Three of the vessels built by Harland & Wolff at their Glasgow works have been fitted with Diesel engines by them and the results have been especially favorable.

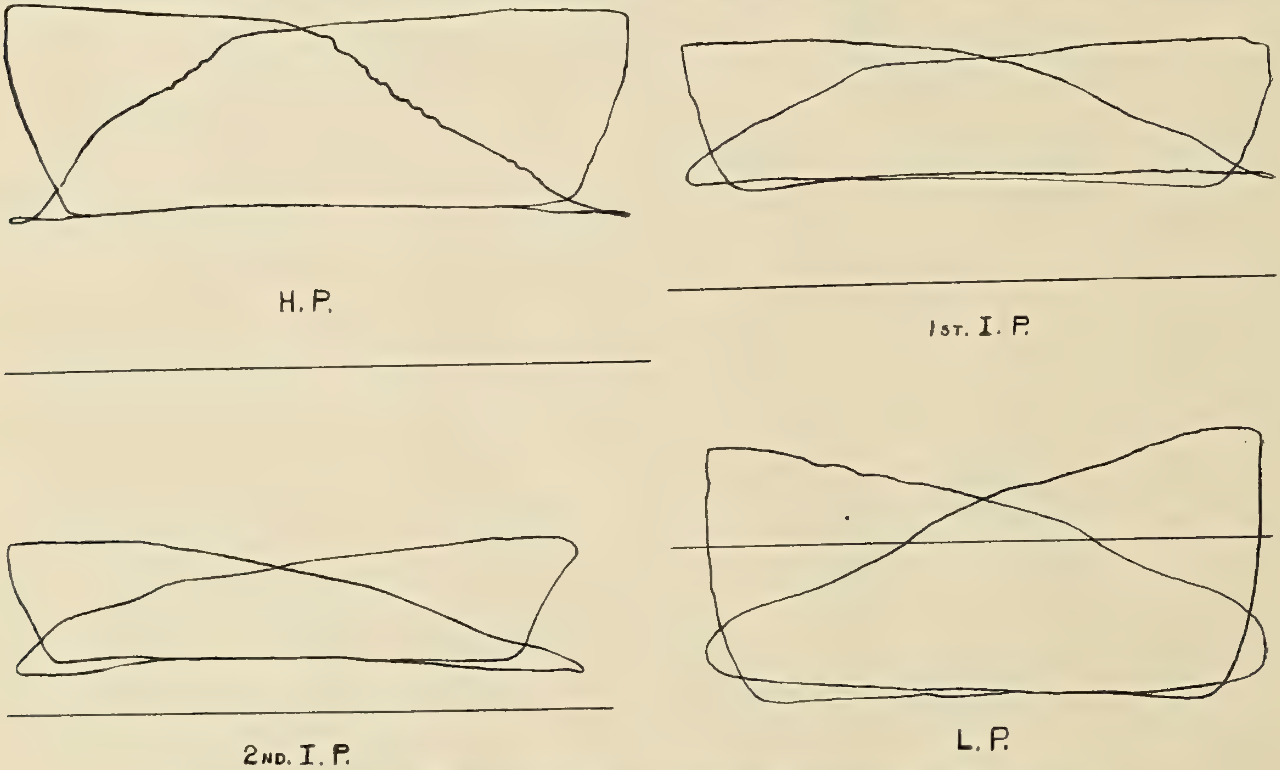


Fig. 16.—Indicator Cards Taken at 11.37 P. M., on Trial Run. Data from Cards Given Below

Boiler pressure	204 pounds
Intermediate pressure[1] rec.	87 "
Intermediate pressure[2] rec.	37 "
Low pressure rec.	9 "
Vacuum	21.5 in.
Revolutions per minute	84.9
Piston speed	594.3
Referred mean effective pressure to low-pressure cylinder	34.4

Cut-offs, high pressure, 3½ in.; intermediate pressure[1], 1¼ in.; intermediate pressure[2], ⅝ in.; low pressure, 0 in.

Mean effective pressure, high-pressure cylinder	82.
Mean effective pressure, intermediate-pressure[1] cylinder	36.25
Mean effective pressure, intermediate-pressure[2] cylinder	15.5
Mean effective pressure, low-pressure cylinder	10.5
Indicated horsepower, high-pressure cylinder	441.
Indicated horsepower, intermediate-pressure[1] cylinder	409.
Indicated horsepower, intermediate-pressure[2] cylinder	369.
Indicated horsepower, low-pressure cylinder	535.
Indicated horsepower, total	1,754.

A New P. & O. Boat

The first of four interesting vessels built for the P. & O. Company's Eastern trade by Messrs. Cammell Laird & Company, at Birkenhead, has been designed and constructed to the special requirements of the trade in the East, and as may be expected from the amicable relations of the steamship company and the constructing firm the *Khiva* appears to be very well adapted for such purposes. Over sixty years ago, Messrs. Cammell Laird & Company built two of the earliest boats of the P. & O. fleet, the *Nubia* and *Pera*, which were then the largest turned out by the famous Birkenhead shipbuilding firm since its establishment in 1829.

The *Khiva* represents the most recent developments in the P. & O. Company's requirements, for their intermediate passenger vessels. It is 480 feet long, with a beam of 58 feet, and a gross tonnage of about 9,000 tons. The loaded draft is 28 feet, and she has a deadweight capacity of over 10,000 tons. The molded breadth of the vessel is 58 feet, the depth molded is 36 feet 6 inches, the speed is about 14 knots and the indicated horsepower of the engines is about 7,000. Special provision has been made for ventilation in hot climates. Lifeboats are provided for a full complement of crew and passengers.

Built of steel in accordance with Lloyd's 100 A1 class, the *Khiva* has a Board of Trade passenger certificate. Quarters for the native crew are provided in the top gallant forecastle, the bridge and poophouse being fitted up for the accommodation of passengers, officers and engineers. The vessel is divided into eight watertight compartments, the bulkheads all extending to the upper deck. Accommodation is provided for 75 first class passengers in cabins on the upper and bridge decks, and 68 second class passengers in cabins on the bridge deck. Ten powerful cargo winches have been provided for dealing with large quantities of cargo, in addition to four steam cranes, each capable of lifting five tons. Four derricks, each capable of lifting five tons and ten tons, are fitted to two pole masts, and there is also one large derrick forward for lifting a weight of 30 tons.

Refrigerating machinery is fitted and large chambers have been arranged for meat and provisions. The general smoking and music rooms are tastefully decorated and upholstered in first-class style. Electric light has been installed throughout the vessel. A Brown steam tiller operates the rudder, and is controlled by a telemotor gear from the bridge wheel house and flying bridge. A Marconi wireless installation is fitted with a receiving and sending house for the operator on the bridge deck.

The machinery consists of two sets of quadruple-expansion engines, the cylinders being 23½ inches, 34½ inches, 48½ inches and 70 inches diameter by 4 feet 6 inches stroke. They are designed to run at about 95 revolutions per minute, and are balanced on the Yarrow-Schlick-Tweedy principle. Steam is provided by two double-ended and two single-ended boilers at a pressure of 215 pounds per square inch, and the engines are capable of developing about 7,000 indicated horsepower. Howden's system of forced draft is installed. Weir's Uniflux condensers are fitted, and the auxiliary machinery is of the most modern type. The propellers are of the built-up type, with cast iron boss and manganese bronze plates. There is on board a very complete workshop and store room supplied with an electrically-driven lathe, drilling machine and other gear. The machinery spaces have an unusually large number of ventilators to secure cool engine and boiler rooms in the hot climate through which the vessel passes, large up-cast and down-cast electrically-driven fans being fitted in the engine room.

The hull and machinery were designed under the supervision of Messrs. C. G. Deane and R. Leslie, the naval architect and superintendent engineer of the owners. Compared with the *Nubia* and *Pera*, which were 292 feet long, with a beam of 39 feet, a B. M. tonnage of 2,173, and nominal horsepower of 450, the new vessel represents the tremendous advance entailed by modern requirements.

Changes in War Risk Insurance

It is learned from the Bureau of War Risk Insurance, Treasury Department, Washington, D. C., that it is now accepting cotton cargoes to Germany at a rate of 3 percent instead of 5 percent as heretofore.

The bureau has just issued its new schedule of general insurance rates on cargoes and ships, dated Washington, D. C., January 11, 1915, as follows:

Rates from any port in the United States to any port in the world (other than those named in the special list), or vice versa, are as follows:

Cargo, Freight and Advances

1. Between ports of the United States, its possessions, or any non-belligerent ports in the Western Hemisphere, one-fourth of 1 percent.
2. Between ports on the west coast of the United States and Japan or China, one-fourth of 1 percent.
3. To non-belligerent ports other than above and not north of Havre in Europe, nor east of Sicily in the Mediterranean, one-half of 1 percent.
4. To all other ports, three fourths of 1 percent.

Vessel (Voyage Risks)

By voyage, meaning from port of loading to not more than two ports of discharge.

1. Between ports of the United States, its possessions, or any non-belligerent ports in the Western Hemisphere, one-fourth of 1 percent.
2. Between ports on the west coast of the United States and Japan or China, one-fourth of 1 percent.
3. To other non-belligerent ports not north of Havre, in Europe, nor east of Sicily in the Mediterranean, one-half of 1 percent.
4. Other ports, three-fourths of 1 percent.

Vessel (Time)

Time policies to be issued for a period of ninety days only, rate 1¼ percent.

If the insured agrees to a warranty reading: "Warranted using only non-belligerent ports in the Western Hemisphere," five-eighths of 1 percent.

All rates subject to change without notice and effective from the date thereof. (January 11, 1915.)

Lloyd's Shipbuilding Returns.—Lloyd's reports show that 462 vessels of 1,627,316 gross tons were under construction in the United Kingdom at the close of the quarter ended December 31. This is about 96,000 tons less than at the end of the last quarter.

Obituary.—Professor Alexander J. Maclean, professor of naval architecture in Webb's Academy and Home for Shipbuilders, Fordham Heights, New York, died December 19 at his home in New York, aged fifty-three years. Mr. Maclean was apprenticed in the British Admiralty Dockyards at Sheerness-on-Sea and later was connected for several years with the United States Navy Yard, Norfolk, Va., and with the William Cramp & Sons Ship and Engine Building Company, Philadelphia, Pa. Professor Maclean was associated with Webb's Academy for eighteen years, and during this time co-operated with J. W. Millard in the design of the Municipal ferryboats for New York city.

Salvage Work on the Empress of Ireland

A Distinct Advance in Deep-Water Salvage Achievements—Methods Employed and Difficulties Overcome

BY ROBERT G. SKERRETT

The recently completed salvage operations on the sunken steamship *Empress of Ireland* is another example of the courage and the capacity of the skillful diver. The recovery of the mails and bullion aboard that ill-fated craft is an example of submarine engineering that stands out conspicuously because of the extreme difficulties to be overcome in an exceptionally dangerous undertaking.

As most of us know, the collier *Storstad* rammed the *Empress of Ireland* during foggy weather, tearing a great gash in the starboard side of the liner. The injured ship filled quickly and settled to the bottom upon her wounded side. Because of the short time she remained afloat after being struck, hundreds of her passengers were caught between decks and carried down with the stricken ship. For some time after the catastrophe there was no part of the vessel above water, and the buoys planted, shortly after the sinking, by the Canadian authorities, merely indicated in a general way the place where the *Empress of Ireland* had foundered. This was broadly the situation when the Dominion Government and the Canadian Pacific Railroad took steps toward certain salvage operations.

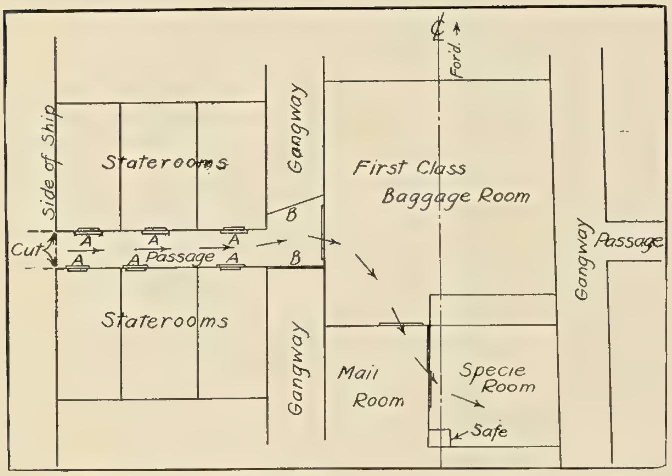


Fig. 1.—Plan of Part of Upper Deck of the *Empress of Ireland*

The Canadian Government wished to recover the mail pouches and the Department of Marine and Fisheries desired later on to have the masts of the wrecked liner removed. This became necessary when the vessel shifted her position and raised her spars right in the path of navigation. Certain of the underwriters, representing shippers and the owners of the craft, desired, if possible, to salve the silver bullion on board and to get out the purser's safe, while the Canadian Pacific Railroad, the owners of the craft, were especially anxious to recover all of the bodies of the passengers that were carried down with the ill-fated ship.

Upon first foundering, the *Empress of Ireland* settled to the bottom in water about 138 feet deep at low tide. At that point in the St. Lawrence the average tidal variation is fully 14 feet, but at times it is even greater, and there is always a very swift current except for the short period of the slack. This, of necessity, added greatly to the difficulties of the task before the salvors, and, as it proved, made it very hard for them even to locate accurately the wreck and to determine the manner in which she rested on the bottom. The water was very cold and the prevalence of light silt made the depths almost black.

Location of the Wreck

When first properly located, the *Empress of Ireland* lay flat on her starboard side, but after a while her cargo shifted and she partly righted herself so that her heel was about sixty degrees toward her wounded side, and, to add to the burdens of the salvors, the vessel sank deeply into the soft mud of the river bottom. This state of affairs made the recovery of the bodies in the open deck spaces hard enough, but it measurably increased the perils involved in getting out the dead from inside the ship, and especially in the steerage. It is a fact worth noting, however, that only one diver lost his life during the operations, and his death was due to a slip which dropped him from the wreck into deeper water.

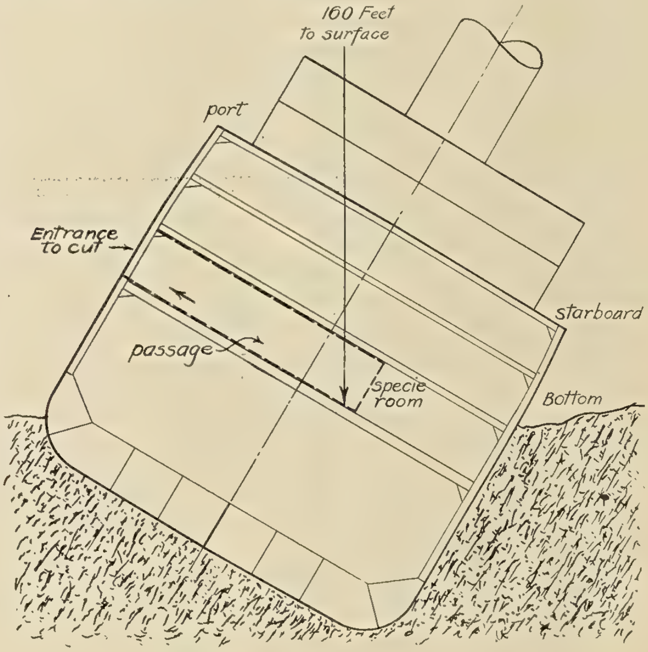


Fig. 2.—Diagram Showing Position of the Vessel

All of the divers engaged in the work were deep-water men, and a dozen of the most skillful and experienced obtainable were secured. Some of these were naval divers from the British cruiser *Essex*. Ultimately the maximum depth in which the divers worked reached a matter of 160 feet, and it was necessary that the greatest care should be taken of the men engaged. Because of the unusual dangers involved, the divers worked in pairs, and as soon as one couple came up from their shift below two others were ready to go down. Their equipment consisted first of diving gear made by Siebe Gorman & Co., afterwards supplemented by diving dress manufactured in the United States. Some important modifications were made in both, and one of them was in the shape of a slot cut in the valve seat of the air supply so that the diver could not shut off

his air completely. Enough leakage was thus insured to keep him alive until help could reach him.

Compressed Air Equipment

The diving practice of the British Admiralty was used as a basis for the operations, and this was amplified by later experiments made in the United States Navy, the latter substituting storage tanks of compressed air for the direct feed from the regulation hand pumps. Indeed, working the latter proved too exhausting even when four men were engaged at the cranks, and it would have been well-nigh impossible to have completed the work in the time actually taken but for the tank system. The salvage vessel, the schooner *Marie Josephine*, was also equipped with a decompression chamber, similar in construction to that used in New York City in tunnel work and in foundation sinking. Happily, the men in charge of the undertaking were thoroughly familiar with compressed air practice in construction work, and their discipline saved the divers from the ill-effects of occasional carelessness. Owing to the coldness of the water, it was found impossible for the men to work with bared hands for any length of time; their fingers became numb. Therefore, they were provided with rubber mittens which were thin enough not to impair seriously the acuteness of their sense of touch, that faculty so vital to the diver when working in dark waters.

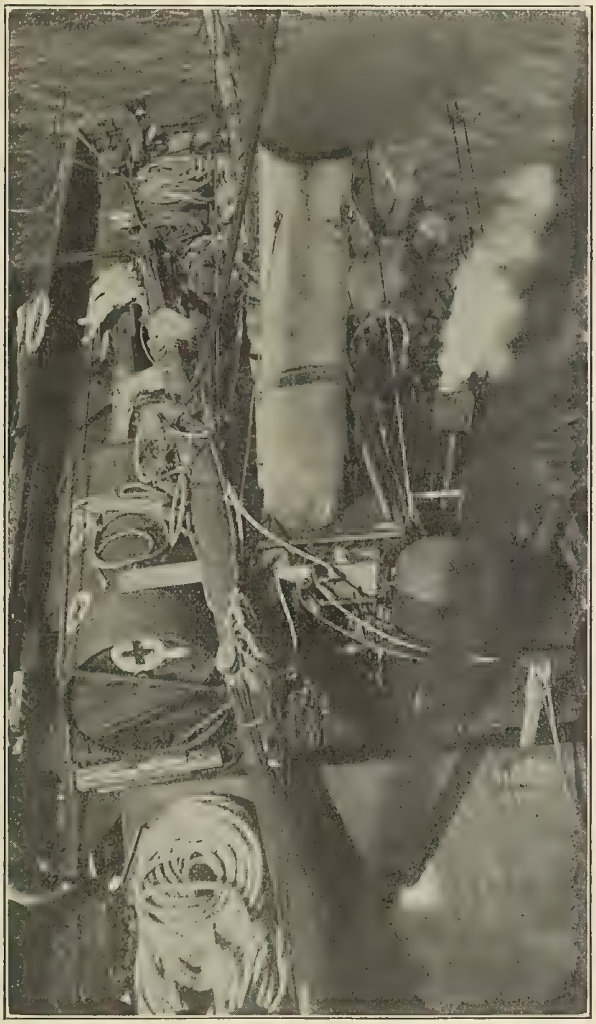


Fig. 3.—Looking Down on Deck of Salvage Vessel *Marie Josephine*

Fig. 4.—Hoisting the Safe Aboard the Salvage Vessel

Simultaneously with the recovery of the bodies the work preliminary to the actual recovery of the treasure and mails was carried on. The first difficulty in the inky depths was to locate on the slanting port side of the ship the position of the athwartship passage which constituted the natural route to be followed in reaching the specie room and the mail compartment. This passage terminated at the side of the vessel, with nothing more to indicate it than a single air port exactly like many others forward and aft of it. After a good deal of exploring, the divers working toward a common center by approaching from each end of the hull, this particular air port was discovered, but, of course, it was not a sufficient opening for admission into the craft.

Pneumatic Tools Used in Removing Plating

By permission of the hull underwriters, a cut was made at that point large enough to admit the divers, and the plating was removed by means of a series of holes drilled for the purpose. This particular operation was a noteworthy achievement. The drilling was done in exactly the same way that an opening of that sort would have been made in the shipyard. "Little David" air drills were used, and these pneumatic tools worked admirably at that depth. A proper set-up or backing, or, as it is called in iron work, an "old man," was placed over the spot to be drilled, and the divers worked on the Taylor differential piece-rate system. Despite the hampering conditions under which the divers did their work, the time required for the task

was but little in excess of that for a similar job in the free air. Don't forget that the ship had a heel of sixty degrees and that electrical submarine lamps gave but a dim illumination in the muddy waters of the St. Lawrence.

With this opening cut in the skin of the ship the problem of removing the bullion, the purser's safe, and the mail pouches was a long way from being solved. The salvors reasonably feared that even so their plan for entering the strong room would not prove feasible, inasmuch as the path to it was decidedly intricate and there were a discouraging number of openings into which the divers might mistakenly turn and get lost or foul their connections leading to the surface. Fig. 1 shows how thoroughly justified the salvors were in their fears. It was realized that the ship's structure intervening between the outside plating and the specie room could be blasted

Fig. 5.—Compressors and Storage Tanks

and torn away, but shattered plating and shivered bulkheads would only increase the peril to the divers. Finally it was decided to seal one by one the flanking doorways in the athwartship passage and then to bulkhead off the fore-and-aft gangway so that there would be a straight and solid-walled path to the wide doorway giving admission into the first class baggage-room.

Model Shows Construction of Hull

This was done, and besides giving a direct lead in and out for the divers, void of fouling projections, it offered an easier route for the things to be salved. But before any of the divers were allowed to enter the body of the ship on this quest they were thoroughly drilled by means of a pasteboard model showing the internal structure to be encountered. The men were made to familiarize themselves so thoroughly with the physical conditions of the hull that they could tell with their eyes closed just what was adjacent to them at every point along the route either in entering or leaving the sunken vessel. This precaution, although it consumed some valuable time, proved a wise one in the end, because it not only safeguarded the lives of the divers, but it actually expedited the work of recovering the silver, the safe and the mail pouches.

The purser's safe was set into a niche built especially for it, and even under normal conditions with the steamer afloat it would have been a troublesome thing to dislodge and to get out of the room and on to the deck. With the ship heeled over and sunk, and with her inner body as black as night, obstacles were multiplied. Besides these, the silt that had worked into the vessel made the deck very slippery. The divers themselves could not do any real labor at that depth, and the safe had to be drawn out by power applied at the surface. It should be remembered that the purser's strong box was 160 feet down from the tide level. Hoisting out that safe was a very neat piece of work and had to be controlled exactly at every stage of its journey outward and upward. The pull on the wire rope had to be perfectly steady, and from time to time the hawser was stoppered. The utmost care had to be taken to prevent the line from cutting itself at sharp turns, and these preparations had to be made deliberately and carefully. It was with intense relief that the divers got the safe clear of the hull and gave the signal for a straight haul upward. The work of getting out the bullion was likewise hard because of the position of the specie room, but the ingots could be handled separately and were loaded in a canvas bag and hauled up with reasonable ease.

Divers Communicate Through Telephones

The ordinary signal code of the diving fraternity would have been of little avail for the men when working inside

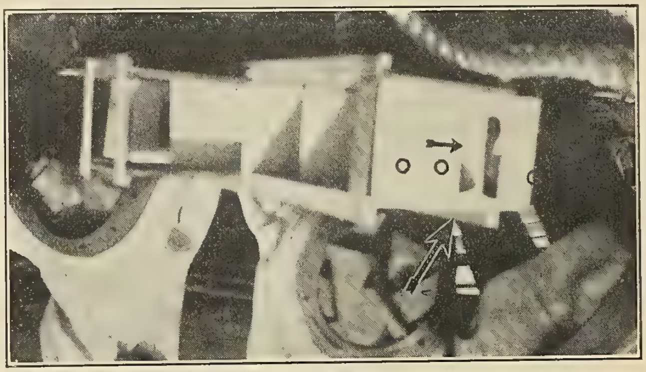


Fig. 6.—Cardboard Model of Ship's Structure Leading to Strong Room. Arrow Indicates Cut in Side of Ship

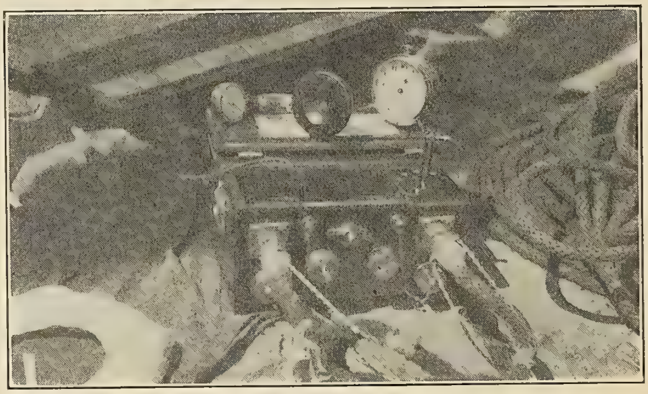


Fig. 7.—Submarine Telephone Set

of the hull. It was realized at an early stage that telephones would be necessary in order that the divers could be in constant communication with the people at the surface, as well as able to talk to one another through a relaying operator on the salvage craft. The English telephone gear supplied with the Siebe Gorman suits is a very efficient apparatus; but even so, the outfit was considerably altered and improved by the adoption of some modifications in accordance with the latest practice in American telephone engineering. Four of these telephones were used, and they rendered invaluable service.

In this work the Canadian Government employed the Canadian Salvage Association, which has the right to operate by the processes and under the patents owned by the Yankee Salvage Association of New York City. The Canadian Pacific Railroad employed the same company to recover the bodies.

Electricity on Board Ship

BY J. E. BULLARD*

Electricity is extensively used on shipboard for all purposes requiring light, heat or power. The units employed vary in size all the way from the little two or four-candlepower portable lamp receiving its energy from a battery of six dry cells to the large electric motors which are to be used to propel the new superdreadnought *California*. There are many advantages possessed by electricity for each different application in the three fields—light, heat and power.

Light

There is no boat so small that it need be without electric lights. With a two-candlepower or a four-candlepower miniature Mazda lamp in a portable holder attached to a few feet of lamp cord, and a dry battery of six cells, one will have a light for intermittent service which he will soon consider indispensable. For such service an ignition battery, which has become too weak for ignition purposes, will often be found to serve admirably. A battery of from twelve to sixteen cells will supply current to operate a four-candlepower miniature Mazda lamp from sixty to sixty-five hours. These cells should be connected in series multiple; that is, divided into four groups of four cells each, with the zinc terminal of one cell connected to the carbon terminal of the next cell in groups of four, the zinc terminals at the ends of the several groups connected together and the carbon terminals at the opposite ends also connected together. This makes three or four sets, as the case may be, of four cells each, connected in series, the several sets being connected in multiple.

It may be well to define the words series and multiple as used here. Series connection means that the carbon terminal of one cell is connected to the zinc terminal of the next cell, the carbon terminal of that cell to the zinc of the next, and so on. Multiple connection means that the zinc terminal of one cell is connected to the zinc terminal of the next, and so on. The carbon terminals are connected to each other in the same manner. In this system of connection we have all the zinc terminals connected together and all the carbon terminals connected together. In series connection there is only one wire connecting any one cell to the next cell in the battery. In multiple connection there are two parallel wires connecting any one cell to the next cell in the battery, and for that reason this system is sometimes called parallel connection. Series connection increases the voltage or pressure of electricity, and multiple connection increases the current or quantity of electricity.

An electric light is the only light which it is safe to use around the engine or the gasolene (petrol) tank. When it is such a simple matter to enjoy the use of electricity there is no excuse for endangering life and property as one does when he uses a lantern or other flame light to examine his engine or fuel tank.

Where several lights are required generators can be secured, which can be readily attached to the engine. These generators are automatically controlled and can be used either with or without storage batteries. The storage battery, however, is always desirable, as it furnishes light without the necessity of starting the engine.

Large boats, yachts and ships require lights of all sizes, and all their lighting needs can be met best by the use of electricity. Large searchlights are on the market which are controlled electrically. These lights have two motors in their base which train the beam in altitude and azimuth. These motors are readily controlled from a remote point. This means that the light may be mounted in one part of the boat and controlled from some distant part of the boat.

The safety, cleanliness, convenience, reliability and ease of control of electric lighting recommend it very highly to the marine engineer and naval architect. This statement is borne out by the fact that the new Argentine battleship *Moreno* has a grand total of 3,000 electric lights.

A motor boat of forty to forty-five feet in length can be well lighted by twelve four-candlepower lamps. The running lights and the anchor light would each contain a six-candlepower lamp, the binnacle light a two-candlepower lamp and the searchlight one of twenty-candlepower—a total of one hundred candlepower. The power necessary to supply current to these lamps would be only about one-fifth of a horsepower. A storage battery of one hundred ampere-hours would run the lights continuously for about eight hours.

Heat

Electric cooking equipment is so well adapted for use on shipboard that there are large steamships on which all coal and oil fires for cooking purposes have been eliminated. Perhaps the largest installation now in actual operation is that on board the U. S. battleship *Texas*. The electric ranges on this battleship have been in operation since March 12, 1914, and since that time have served three meals a day to a crew of 900 men and to 70 officers.

The equipment consists of ten electric ranges in the general mess galley, five in the officers' galley, and two bakers' ovens. Coffee, tea, boiled meats and vegetables for the general mess are prepared in steam jacketed caldrons, and therefore do not require the operation of the electric ranges. In the officers' galley, where less food is prepared, electricity is used exclusively for cooking, and even for boiling.

Some idea of the magnitude of the cooking operations which must be carried on to feed the crew of 900 men is gained by the knowledge that over 6,000 pounds of bread alone is consumed each week, that a breakfast may require 180 dozen fried eggs, and a dinner 600 pounds of roast meat.

Mr. G. L. King, first-class cook on the *Texas*, states that he considers the electric range far superior to the coal-fired type. (1) The use of the electric type eliminates the necessity of handling coal and ashes, consequently there is less dirt present in the room where the food is prepared; (2) the electric range is much cooler to work around, the heat being hardly noticeable even on hot days; (3) it is much easier to cook with the electric equipment, as the temperature is uniform.

Power

Electricity is now used on shipboard for every purpose requiring power. On the new Argentine superdreadnought *Moreno* we find 275 motors having a total rated horsepower capacity of 4,000, and varying in size from the little one-third horsepower motor driving the vacuum cleaner, and the half-horsepower motors driving the speed signal balls, the ozonizer pumps, and the meat slicer, to the one hundred and fifty horsepower motors driving the coaling winches and steering gear.

The current for these motors is supplied by four 375 kilowatt turbo-generators of the horizontal type. Two of these machines are located forward and two aft on the lower platform deck below armor. On the gun deck there is a dynamo room containing two Diesel oil-engine-driven generators of 75 kilowatt capacity for harbor use when the fires are drawn. The more general adoption of the modern high-speed steam turbine for ship propulsion,

* Member of the Society for Electrical Development.

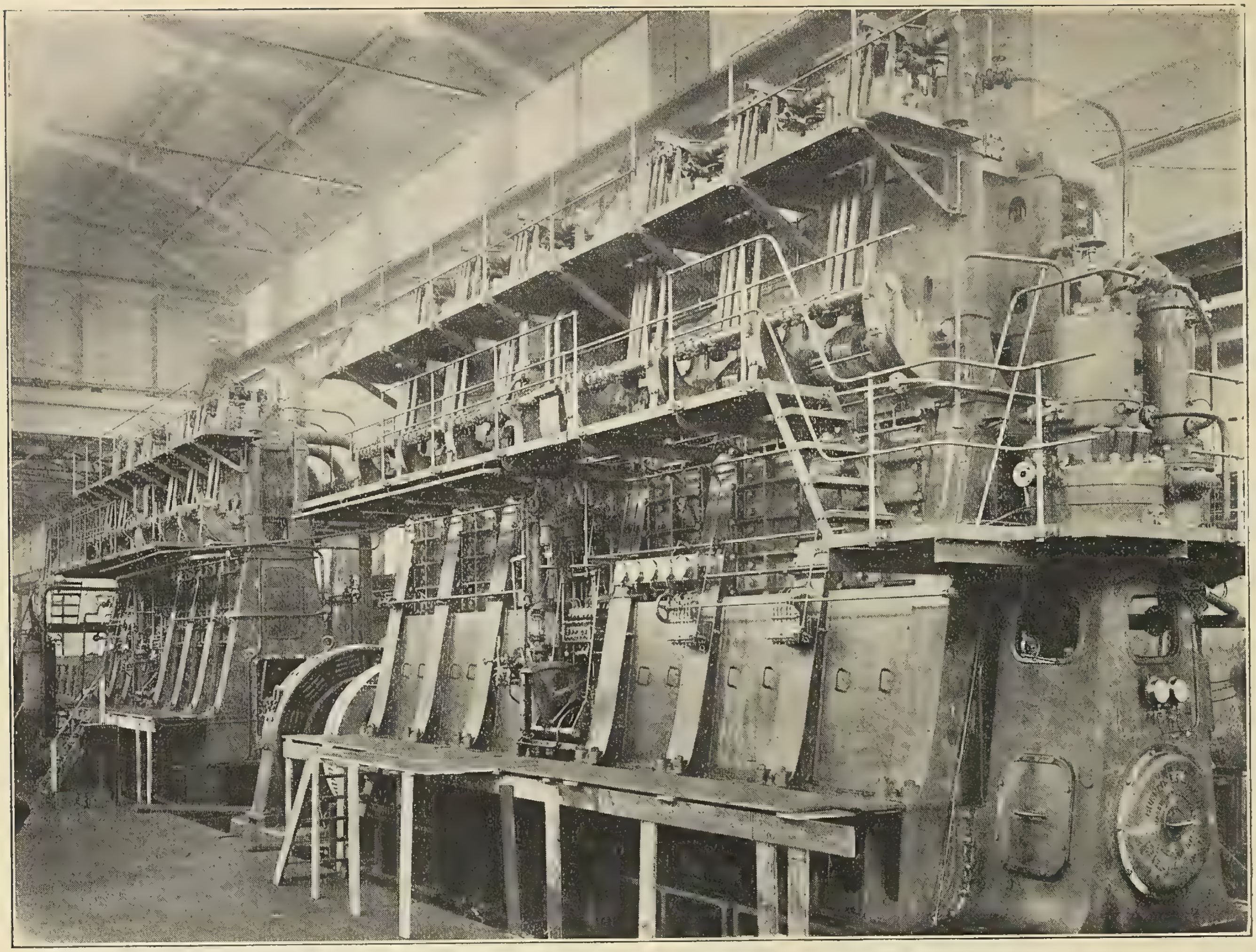


Fig. 1.—Six-Cylinder Diesel Engines, Built by Burmeister & Wain for the Motor Ship *Tongking*

which aside from its high speed appears to be the ideal steam engine for this purpose, has been delayed by the difficulty experienced in manufacturing reduction gearing which is sufficiently reliable, noiseless and efficient. This has caused many investigators to turn to electricity for the solution of the problem. As a result we find in the United States Navy the collier *Jupiter* with turbine electric propulsion. The steam turbine drives generators which furnish electricity to the motors connected to the propeller shafts. This permits of the turbine speed being as high as efficient operation requires, and the placing of the turbines in any convenient part of the ship without regard to the propeller shafts. This system has proven so satisfactory on the *Jupiter* that the Secretary of the Navy has authorized the installation of a steam turbine electric propelling plant on the superdreadnought *California,* which will be built at the New York navy yard.

Motor Ship Tongking

The official trip of the *Tongking,* the eleventh large ocean-going, motor ship built by Burmeister & Wain, at Copenhagen, Denmark, was carried out successfully in the Copenhagen Sound, October 7. This vessel is a sister ship to the *Siam, Annam* and *Malakka,* all belonging to the East Asiatic Company here, and has the following dimensions: Length between perpendiculars, 410 feet; breadth, 55 feet; depth, molded, 30 feet 6 inches; deadweight capacity, 9,700 tons.

The engine installation in the *Tongking* is quite similar to the installation in the *Malakka,* but differs from the engines in the *Siam* and *Annam* in that the latter have eight cylinders each and develop a total of 3,000 indicated horsepower for each ship, while the engines in the *Tongking* and *Malakka* have six cylinders each and develop 3,100 indicated horsepower. Each engine is fitted with its own main compressor, manufactured by Burmeister & Wain. These compressors have such a capacity that each gives sufficient air for the injection of fuel and a further surplus for filling up the maneuvering reservoirs, for the whistle and for the oil burner for the heating boiler. The main engines are of the same general type as those installed in the *Fionia,* although somewhat smaller, developing 3,100 indicated horsepower as against 4,000 indicated horsepower for the *Fionia.*

As in the previous motor ships built by Burmeister & Wain, all the auxiliary machinery is electrically driven, and all the pumps are independent of the main engines. The auxiliaries include two cooling water pumps, two pumps for forced lubrication, and two sets of bilge, sanitary and piston cooling pumps. All these pumps have such a capacity that it is only necessary to have one set running at a time, while the other stands by as a spare.

The pistons of the main engines are cooled by sea water, which is conducted to and from the pistons by means of telescopic pipes, according to the same system as adopted for the larger engines in the *Fionia,* as this arrangement during the first voyage of this ship to Bangkok has proved to be thoroughly satisfactory.

Because each main engine is fitted with a main compressor, the auxiliary engine installation is somewhat different from the installations in the *Siam* and *Annam,* where the auxiliary engines drive the compressors. On board the *Tongking* and *Malakka* there are installed three two-cylinder auxiliary Diesel engines, directly coupled to dynamos, each having a capacity of 90 brake horsepower. This arrangement gives a very high degree of reliability of the working of the auxiliary machinery, which is all electrically driven. During normal speed at sea the power consumption is about 50 brake horsepower. Two of the auxiliary engines are always running, while the third is standing by as a spare, so that a sudden closing down of one of the engines will cause no interruption of the working, as the other engine will easily be able to take the whole load. When loading and unloading with all winches working, two of the engines are kept running, these being able together to give the maximum power for the winches; the third engine is therefore always standing by as a spare.

During the trial trip a speed of 12.71 knots was attained on a horsepower of 3,328. The oil consumption was 149 grammes of ordinary Borneo crude oil, including the consumption of fuel for the auxiliary engines. It is noteworthy that during the trial trip the whole engine installation worked quite satisfactorily, although the engines had not previously been given a shop test. After the trials the ship was accepted by the owners, the East Asiatic Company, and taken into the Copenhagen free port to receive a cargo. She started on her maiden voyage from Copenhagen to China and Japan on October 10.

While the *Tongking* is the eleventh big ocean-going motor ship built by Burmeister & Wain, this firm now has in hand another large motor ship for Rederiaktiebolaget "Nordstjernan," Stockholm. This vessel is a sister ship to the *Suecia, Pedro Christophersen, Kronprins Gustaf Adolf* and *Kronprinsessan Margareta,* and will be completed at the end of this year.

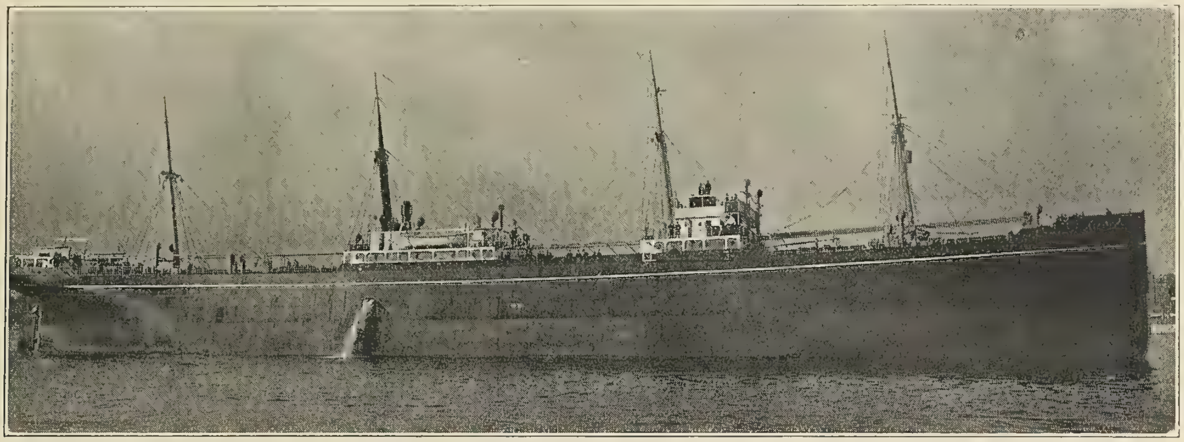
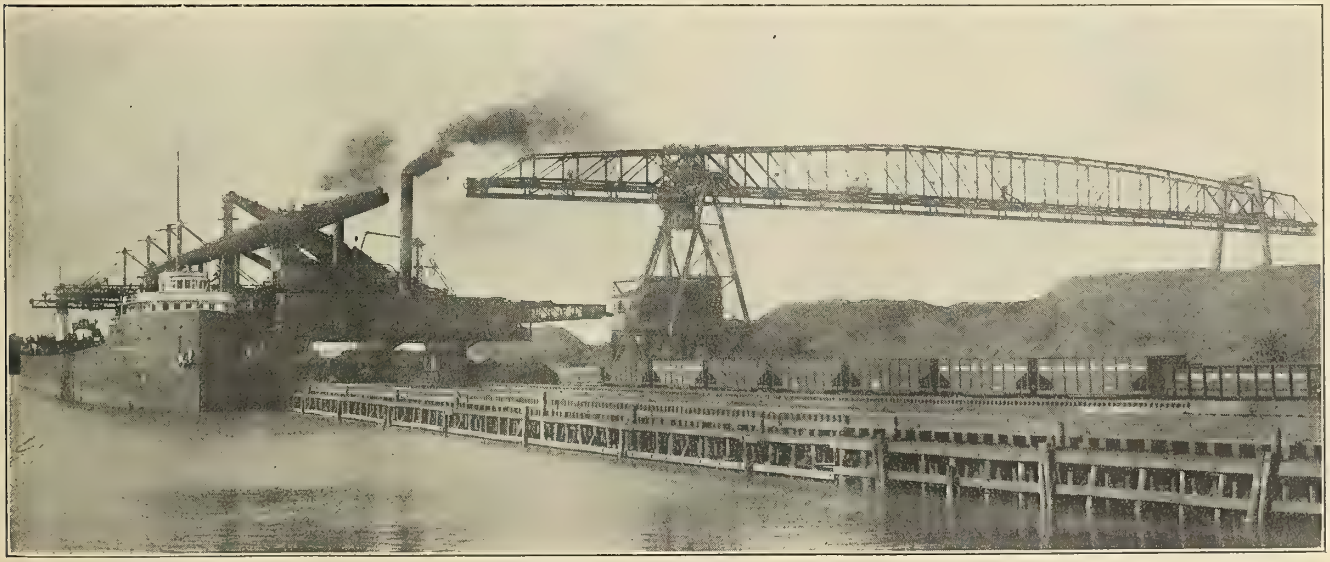


Fig. 2.—Motor Ship *Tongking*. Length 410 Feet, Beam 55 Feet, Deadweight Capacity 9,700 Tons

New Ore Unloading Plant at Huron

A steam-operated ore unloading plant with a guaranteed capacity of 660 tons per hour was recently installed by the Wellman-Seaver-Morgan Company, Cleveland, Ohio, for the Wheeling & Lake Erie Railroad, at Huron, Ohio. This plant consists of two 15-ton capacity Hulett unloaders and represents the highest development in ore unloading machines of the steam-operated type. A steam-operated plant was installed on this dock, for the reason that there was no available electric power for operating the machines.

The unloaders, which are of the well-known Hulett type, consist essentially of heavy steel framework elevated on gantry legs which are mounted on trucks designed to



Wheeling and Lake Erie Ore Plant at Huron, Ohio

travel along the runway on the dock. The girders of this main framework are extended back of the rear runway so that ore can be discharged under this cantilever, to be reclaimed by a bridge spanning the ore storage yard. The main girders of the machine span yard tracks between the front and rear runway, and ore can be discharged from the machine either into cars standing on these tracks or into the temporary storage pile under the cantilever.

Mounted on the main girders and traveling on rails supported by them is a heavy trolley carrying a walking beam from the outer end of which is supported a rigid bucket leg which terminates at the lower end in a Fickinger-Blake patented bucket having a capacity of 15 tons.

The walking beam supporting the bucket leg is of such length that with the trolley in the forward position and the open bucket shells at the water level, the maximum reach of the machine is approximately 50 feet 7 inches, this reach being sufficient to unload ore from any of the largest ore-carrying boats on the Great Lakes. Located between the main girders and running on a track extending their entire length is the conveyor car, which is used for the purpose of transferring the ore from the bucket into cars or storage, as desired.

The conveyor car, when at the forward end of its runway, is in such position that the ore can be dumped directly into it from the bucket, and the car is then drawn back by means of ropes to the desired position for dumping.

Steam Power Plant

Power for operating the machine is supplied by means of a 275 horsepower locomotive type boiler, which is located in a boiler house at one side of the main girders. This boiler supplies steam for operating the haulage engines for the conveyor car, and also for supplying steam to the pump and water accumulator, for supplying the operating cylinders which control the motions of the trolley, walking beam, bucket leg and bucket, these motions being hydraulically controlled.

The steam is carried from the boiler to the pump and accumulator by means of a walking pipe at the side of the trolley. This pipe is supplied with the necessary swivels and is of such length that it will accommodate the extreme travel of the trolley. The main trucks of the machine are ten in number, five under the forward leg and five under the rear leg. Four of the trucks under each leg are carried in pairs on heavy steel equalizing beams in the sill girders. The fifth truck is carried on springs and is located under the outside girder, supporting one side of the boiler house. Two trucks on the front leg and two on the rear leg are provided with driving gears and connected to the conveyor car haulage engine, which is also used for the purpose of traveling the machine along the dock.

The Trolley

The trolley is mounted on twelve wheels at the forward side and four wheels at the rear side, two of the rear wheels being underrunning on a track provided for this purpose to prevent the uplift at the rear end of the trolley when the machine is working at full load conditions. The forward trolley wheels are mounted on springs in the truck frames. The trolley is moved back and forth on its runways by means of ropes which are controlled by two hydraulic cylinders of the plunger type, which are provided with a common crosshead in which are mounted sheaves for the trolley rope. The necessary multiplication of parts is obtained by passing these ropes around sheaves carried in the trolley framework, and the ends of the rope are secured to each end of the trolley runway.

At the top of the trolley framework are heavy bearings which carry the walking beam trunnions. The walking beam is raised and lowered by means of a single plunger type cylinder, provided with a crosshead at the outer end, and in this crosshead are mounted sheaves around which the beam hoist ropes are passed, the ends of the rope being attached to the back end of the trolley framework. The outer end of the walking beam is out of balance to such an extent that the bucket leg descends by gravity.

The bucket leg is mounted on a swivel bearing carried on trunnions in the forward end of the walking beam, this swivel being so arranged that the bucket leg can be rotated a three-fourth revolution either way from central position. The motion of rotating is controlled by ropes operated by a double cylinder of the plunger type, which is located at the rear on the top of the walking beam. This motion of rotation of the bucket leg enables the operator to turn the bucket in any position to facilitate the unloading of ore from the boat.

Operation of the Bucket

The bucket at the lower end of the leg is of the Fickinger-Blake type and is operated by means of cylinders located in the bucket leg. All the motions of the bucket, walking beam and trolley are controlled by the operator, who is stationed in the bucket leg directly over the bucket. Convenient to this position are located the pilot valves for operating the main valves controlling the various operating cylinders. The water for operating these machines is snpplied by means of a Worthington compound pressure type pump, which supplies water to a steam hydraulic accumulator located at the rear of the trolley. The capacity of this pump is sufficient to supply water to all of the cylinders in sufficient quantity to operate the machine at its maximum speeds.

In addition to the operator in the bucket a second operator is required, who has control of the conveyor car and the moving of the machine along the dock.

These machines have a guaranteed capacity of 330 tons per hour for each machine, based on unloading the entire cargo of modern boats. Their capacity for unloading in free ore, however, is very much in excess of the above amount, as the capacity of the machine is very materially decreased after the ore has been unloaded to such a point that shoveling is required in order to clean up the cargo.

Bureau of Navigation Shipbuilding Returns.—According to figures published by the Bureau of Navigation, Department of Commerce, 1,163 vessels of 255,630 gross tons were built in the United States in 1914 as compared with 1,501 vessels of 382,569 gross tons built in 1913. Eighty-six steel steamships aggregating 157,496 gross tons were built in 1914, as compared with 114 aggregating 229,-327 gross tons in 1913. For the six months ended December 31, 516 vessels of 107,901 gross tons were built, as compared with 644 vessels of 163,849 tons in the corresponding period a year ago. In the month of December 62 ships of 15,103 gross tons, built in United States shipyards, were officially numbered, five of them aggregating 10,385 gross tons being steel steamships. Sixteen foreign-built ships of 59,805 gross tons were also added to the American merchant fleet during the month in accordance with the Act of August 18, 1914.

Annual Meeting.—The annual meeting of the National Association of Engine and Boat Manufacturers, Inc., will be held at 11 A. M. February 4 at 29 West Thirty-ninth street, New York.

New Fruit Carrying Steamer van Hogendorp

Steamer for the Atlantic Fruit Company's New Service Between Central America, and the West Indies and Europe

BY FREDERICK C. COLEMAN

The Atlantic Fruit Company, of New York, originally formed to consolidate a number of steamship and fruit importing companies with other interests in the fruit-growing trade, now owns valuable tracts of banana-growing lands, as well as possessing extensive rights and privileges over other tracts of country, through all of which there are railways connecting the plantations with the seaboard. Supplies of fruit have been drawn not only from Jamaica and Cuba, but from Colombia, Honduras, Nicaragua, Mexico and other parts of Central America.

With the object of further developing this business, the Atlantic Fruit Company recently effected a combination of powerful commercial interests in the United States, Great Britain, Canada, the West Indies, Germany and Holland, and arranged for Messrs. Wambersie & Son, merchants and shippers, of Rotterdam, to act as the selling agents and distributors for Europe, and also as the managers of three new steamships intended to inaugurate a service between Central America and the West Indies and Europe.

The order for these three fruit-carrying steamships was placed early in the year (1914) with Messrs. Swan, Hunter & Wigham Richardson, Ltd., of Wallsend-on-Tyne, and on this and the following pages is illustrated the *van Hogendorp,* the first vessel to be delivered. The remaining two vessels were named *van der Duyn* and *van Stirum.* These steamships, named after three eminent statesmen who, in 1813, were instrumental in restoring the throne of the Netherlands to the House of Orange, will be of uniform dimensions and equipment, and will each measure 343 feet in length overall, 331 feet between perpendiculars, 45 feet in width, with a molded depth of 20 feet 1½ inches to the upper deck and 28 feet to the awning deck. Each will have a straight stem, a round or elliptical stern, complete awning deck and full top-gallant forecastle, and will be built to Lloyds highest class, and also to the requirements of the British Board of Trade and the Dutch Shipping Law.

Fig. 1.—*S. S. van Hogendorp,* Built for the Atlantic Fruit Company by Swan, Hunter & Wigham Richardson, Ltd.

Propelling Machinery

The propelling machinery consists of triple expansion direct-acting surface-condensing engines, 23, 38 and 63 inches in diameter by 39-inch stroke, supplied with steam by three single-ended cylindrical multitubular boilers, 15 feet 3 inches diameter by 11 feet 6 inches length, fitted with Howden's forced draft and working at 180 pounds pressure. The total heating surface is 7,300 square feet. The engines and boilers of the *van Hogendorp* were built at the Neptune Works of Messrs. Swan, Hunter & Wigham Richardson, Ltd., and on official trials they gave complete satisfaction when a speed of 14 knots was attained on the measured mile off Tynemouth.

Passenger Accommodations

In addition to carrying fruit these steamships will each have accommodation for 30 passengers. On the boat deck are cabins-de-luxe, furnished with separate bedsteads, wardrobes and toilet tables, and communicating with sitting rooms provided with writing tables, couches and armchairs. Bathrooms adjoin these special cabins. On the same deck is a handsome smoke room paneled in fumed oak and upholstered in leather. Near the smoke

room is a prettily furnished music room or lounge. On the awning deck are suites of commodious staterooms and close at hand is the dining room, the walls of which are finished in white with lightly decorated panels. The captain and officers have their quarters in a deckhouse on the navigating bridge, and the engineers have their apartments on the awning deck on each side of the engine room casing, while the sailors and firemen are accommodated in the forecastle.

Refrigerating Machinery

The carbon-dioxide refrigerating plant, supplied by the Haslam Foundry and Engineering Company, Ltd., of Derby, is capable of maintaining a temperature of from

Cargo Holds

The whole of the fruit spaces are divided into sections, forming bins, and giving about nine bins in each space. The uprights dividing the ship in a fore and aft direction are spaced 4 feet apart, except in the way of hatches. Suitable posts are placed at the corners of the bins, where portable battens are fitted, supported by the ship's stanchions. The bin posts are of the built-up type and in many instances the division battens are portable. Fore and aft battens, 5 inches by 1½ inches, run through mortises cut in the uprights and spaced about 6 inches apart, leaving a space below the lowest batten to the top of the grating, and of about 9 inches above the top batten, to the under-

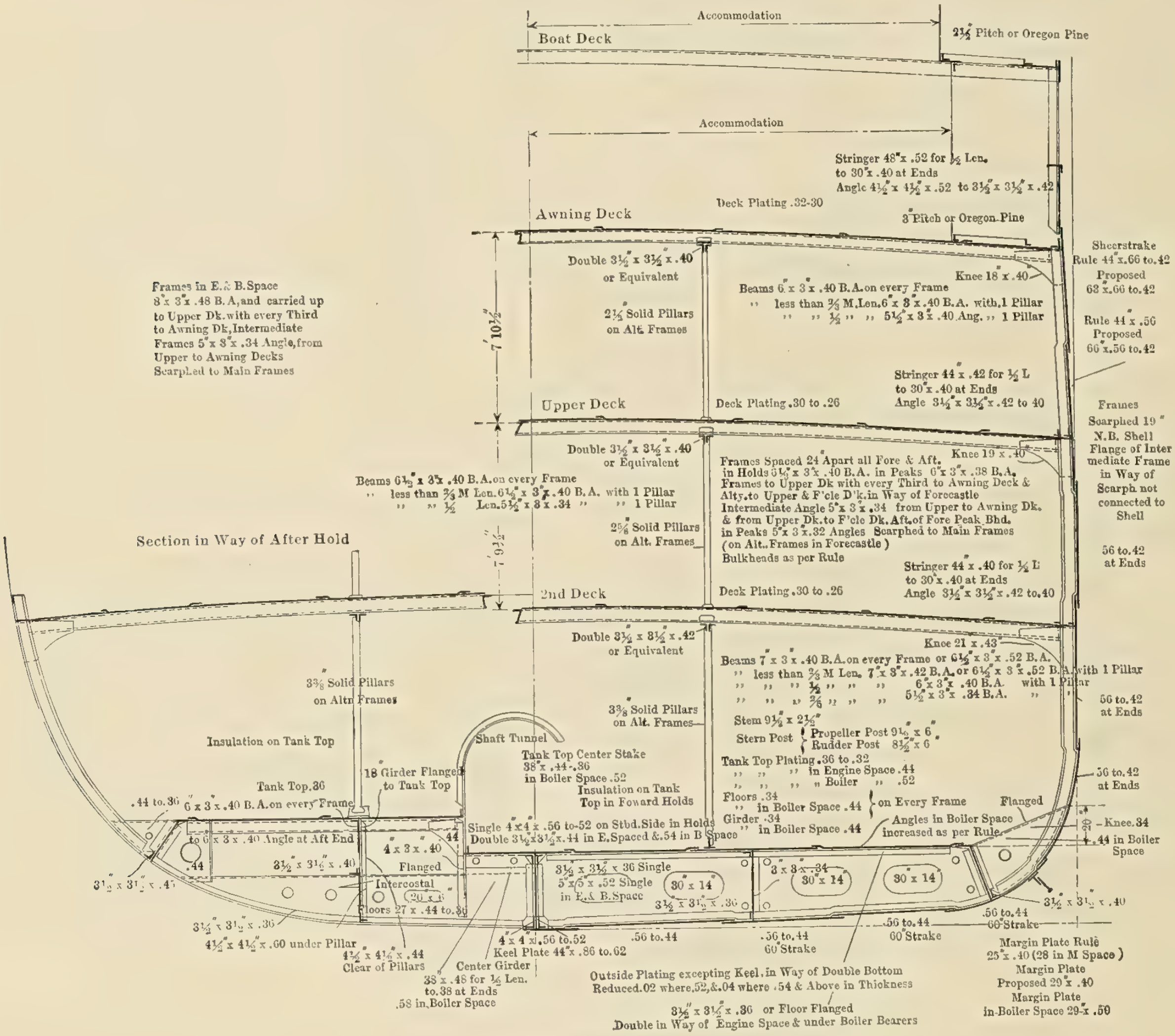


Fig. 2.—Midship Section

50 to 55 degrees, and is fitted in a house on the awning deck abaft the engine casing. The air cooler for the after holds is fitted in a house adjoining the machine room, while the cooler for the forward holds is arranged in the upper 'tween decks at the fore end of the boiler casing.

The outer boundaries of the fruit carrying spaces—that is to say, the ship's side, tank and tunnel tops, shelter deck and end bulkheads, are insulated by granulated cork, and portable sections are arranged at the wing limbers in the hold and also in the way of tank manholes. There are insulated covers to the awning deck hatch, besides the ordinary covers, fitted in sections to suit fore and afters. Spar gratings are arranged to all the decks on which fruit will be laid.

side of the beams. The uprights in the way of the hatches and those which divide the space athwartship are distanced about 5 feet apart. All battens which divide the bins in an athwartship direction and which are portable are arranged so that the battens may be put in place and afterwards prevented from moving about. Portable battens also pass through mortises cut in the uprights.

The steel bulkheads in each space are lined, where not insulated, with battens similar to those dividing the bins. A fruit cage is placed in one corner of each hatch in each 'tween deck and on the hold for breaking out cargo. These cages are built with angle frames, 2½ inches by 2½ inches by ¼ inch, and the sides are sparred similar to the bins, the spars in the bottom of the cage having a space of 1 inch between them.

Auxiliaries

Electric light is installed throughout the ship, the generator being by Messrs. W. H. Allen, Son & Co., Ltd., of Bedford, and the dynamo by the India Rubber & Gutta Percha & Telegraph Works Company, Ltd., of Silvertown, London, E. The steering gear is by Messrs. John Hastie & Co., Ltd., of Greenock. Rapid loading and discharging of fruit cargoes is effected by means of a number of steam winches and derricks, five of the winches being supplied by Messrs. John Lynn & Co., of Pallion, Sunderland, and the windlass is of Clarke, Chapman & Co.'s manufacture. The contractors for the steam heating of these vessels were Messrs. R. B. Charlton & Co., of Newcastle-on-Tyne.

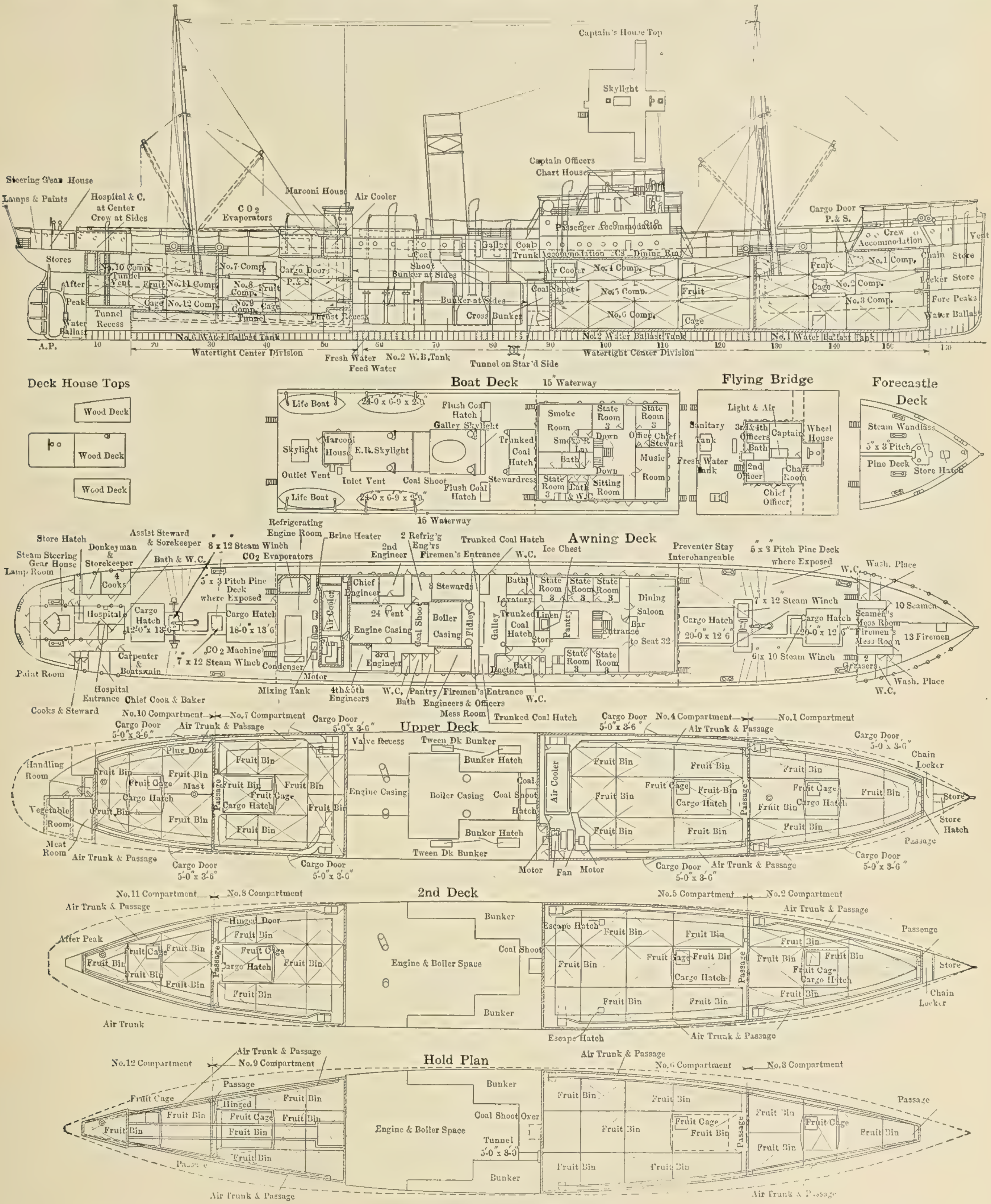


Fig. 3.—Profile and Deck Plans

Wireless

The wireless telegraph installations on the *van Hogendorp* and her sister ships will be carried out by the Société Anonyme Internationale de Télégraphie sans Fil, of Brussels. The alternating current necessary for the working

of each of these sets is supplied by the motor generator. The direct-current motor is directly fed by the ship's dynamo, and is of about 4 horsepower, with a speed of 1,500 revolutions per minute. It is fitted with a suitable starter and field regulating resistance. The alternator has a maximum output of 2 kilowatts and its frequency is 500 and voltage 220.

The switchboard controls the alternating circuit and is fitted with a two-pole switch, a pair of cartridge fuses, a pilot lamp, and ammeter with short circuiting plug and a voltmeter with key. The alternating current is sent through the primary of a step-up transformer, a manipulating key and an adjustable iron core inductance.

The high tension current from the transformer secondary feeds the transmitting condenser, which is made of glass and zinc plates fitted in a lead-lined, oil-tight, teak case. The condenser is discharged through an adjustable multiple spark discharger, which forms, with the primary of the auto jigger and a variable inductance, the primary oscillating circuit. The second oscillating circuit comprises the aerial, aerial tuning inductance, secondary of the auto jigger, one safety spark gap, a hot wire ammeter, and the earth connections. The power used for transmission depends on the number of spark gaps put in circuit, and it is thus easy to adjust the actual range of the station. The voltage of the alternator is regulated in accordance with the number of gaps in use.

The wave lengths in transmission are 300 and 600 meters. The primary oscillating circuit is adjusted to the required wave-length by changing the number of turns of the jigger primary. The adjustment of the secondary circuit is obtained by regulating the number of turns of the jigger secondary and of the aerial tuning inductance. The hot wire ammeter shows whether the two oscillating circuits are well in tune. The variable inductance in the primary oscillating circuit is used for the final adjustment of the two circuits. The aerial and earth leads of the receiving apparatus are connected to two poles of the safety spark gap. During transmission the gap is short-circuited by the spark. During reception the whole current from the aerial goes through the receiving apparatus, so that no changing of connection is needed when sending or receiving.

The main receiving apparatus is a highly sensitive crystal receiver which can be tuned for every wave-length between 250 and 3,000 meters. The apparatus comprises two inductively coupled circuits. The primary circuit is connected between the aerial and the earth. It is composed of an adjustable inductance, a variable condenser, and the primary of the coupling jigger, which is divided into three independent sections capable of being connected in series. The secondary of the jigger, which is also divided into three coils that can be connected by means of a special switch, forms, with a variable condenser, the secondary circuit.

In a parallel with the secondary condenser is connected the detector circuit, composed of the crystal, a potentiometer and the primary winding of a telephone transformer, the secondary of which is connected to the receiving telephone. The crystal is protected by means of a double relay by which it is insulated during transmission. The relay is in series with a couple of dry cells and an auxiliary contact with the manipulating key, which is closed during transmission.

Fig. 4.—Smoking Room

Fig. 5.—Dining Room

A magnetic detector is provided as emergency receiving apparatus. When the latter detector is used, the aerial tuning inductance and condenser of the crystal receiver are used as tuning device. A special commutator permits of connecting up either crystal or magnetic detector. The earth and aerial terminals of the receiving apparatus being connected to the electrodes of the safety spark gap, no changing over of connections is necessary when sending or receiving.

The earth connections are made of brass bolts screwed direct to the hull of the ship. The aerial is made of 42/23 phosphor bronze cables suspended between the two masts by means of high tension insulators. The down leads are connected to the leading-in insulator, which is fixed through the roof of the wireless cabin.

Emergency Set

In addition to the set described above, there is also an emergency set for use in case of accident to the ship's dynamo. This battery set consists of an induction coil, a manipulating key, a battery of accumulators, and a switchboard. The switchboard comprises a double pole, two-way switch, two single pole one-way switches, a resistance of about 5 ohms, a voltmeter, charging and discharging resistances and fuses. It is possible to work the coil with the current of the ship's dynamo, and it is for that reason that a suitable resistance is fixed on the abovementioned switchboard for the purpose of reducing to the proper value the voltage of the ship's dynamo. The induction coil can be worked by the current of the battery

of accumulators, which consists of 12 cells of 96 ampere hours. The cells, of specially compact construction, are fitted in six wooden cases. This set has not been provided for general work, but merely as a standby in the event of the current of the ship's dynamo being interrupted.

The *van Hogendorp* was built to the requirements and under the inspection of Mr. van Helden, the consulting naval architect, and Mr. B. Theil, resident engineer, as representing the owners. Further steamships are on order in Great Britain for this fruit service in order to replace vessels now on charter.

Tank Ship Construction*

BY ROBERT WHITING MORRELL, M. E.

The cargo oil system is so designed that by means of the cargo oil pumps and piping, any tank, port or starboard, can be filled with oil or discharged, or can be filled with sea water or discharged overboard, or any tank can be emptied into any other, on either side; and in some cases, two or more different grades of oil can be handled independently.

The cargo oil pumps are in duplicate, one on either side, capable of pumping from either side. They take steam from the main or donkey boiler (usually they require more steam than a donkey boiler can furnish) and exhaust to the auxiliary steam line. The main steam valve should be fitted with an operating rod controlled from the deck. Each pump is connected to a sea valve located in the pump room. It is desirable to keep the pumps as low as possible, in order to reduce the suction head. The pump room bilges are drained by the oil pumps. There is considerable opportunity for economy by having the main air pump independent from the main engine, so that when in port the oil pumps can exhaust to the main condenser and have the advantage of a good vacuum, the auxiliary condenser usually being inadequate. There is also some question of economy in using compound oil pumps, but the more costly repairs and the varying conditions of steam pressure, discharge pressure, etc., makes the advisability of the compound pumps somewhat doubtful. To a large extent, the oil pumps are used for discharging only, the oil being pumped on board from the shore.

Cargo Oil Piping

The cargo oil piping is of heavy wrought-iron or steel, with screwed flanges faced off and bolt holes drilled. Considering discharging conditions first, we find suction pipes at the bottom of the tanks, running fore and aft, on both sides, leading from the pump room. Near the after end of each tank the suction pipe extends down close to the bottom of the ship, with a flare or bell-mouth and a valve. Two cross-over pipes extend through the centerline between each pair of compartments, so that either compartment connects with either suction line, by means of valves. In order to keep the suction lines low, they should be run through the lightening holes in the transverses, in which case the pipes should be in lengths easily removable. Master valves of the sluice type are fitted at each transverse bulkhead.

Having reached the pumps through the suction lines, the oil is pumped up to the deck through vertical discharge pipes in the pump room. Two of these pipes are necessary in order to handle two different grades of oil simultaneously; and in order for either pump to discharge to either side of the ship, a cross-over connection is necessary between these two pipes. If both pumps are to discharge to either side of the ship, independently, at once, a double cross-over is necessary. The cross-over may be in the pump room or on deck, preferably the latter. Air and drain cocks should be provided in the cross-over. The ends of the cross-over are fitted with Y outlet castings to which the shore hose is attached and which are kept blanked when not in use. Hose davits are located conveniently to these outlets. Lengths of portable pipes are also provided for attaching to the outlets when discharging water ballest, in order to keep the deck free of water. From the discharge pipes at the pump room, one or both pipes are extended aft along the deck to the stern, for use in certain ports where it is necessary to discharge over the stern. Discharge outlets may be provided whereever desired along this stern discharge line.

Filling may be accomplished through the vertical pipes in the pump room, and in addition vertical filling pipes leading to the suction lines are provided where desired, usually one forward and one aft of the pump room, port and starboard. Filling and discharge outlets may be fitted with cross connections or the hose may be led across the deck, whichever is preferred.

It is required that in handling two grades of oil at the same time, the respective pipe lines must be separated by two valves, so that if one valve leaks the grades will not mix. It is also required in ships having the filling and suction pipes of their fuel bunkers attached to the main cargo pipe lines, that the bunker shall be isolated from the cargo oil by removing sections of piping from all cargo lines leading into the bunker and blanking the exposed ends. This is to prevent naptha or other explosive cargo from getting into the fuel space. In order to use the cargo piping for filling or discharging the bunker, the blanks must be removed and the pipes connected up.

The main suction and discharge lines must be fitted with expansion joints. The suction lines are anchored at the transverse bulkheads, and must have an expansion joint in each tank. The deck discharge line is anchored at the deck tees and generally one expansion joint in the line is sufficient. This line has a tendency to work in rough weather, putting a severe strain on the joints. Heavy bracket supports are therefore fitted on the deck to secure the piping, usually with lead liners next to the pipe. These should grip the pipe solidly, but not enough to prevent motion entirely.

The cargo oil piping is carefully tested out at the shipyard when completed, at a pressure anywhere from 150 to 250 pounds per square inch. The piping when under pressure has a tendency to distort, which puts a strain on the flanges. This also should be taken into consideration in designing the support brackets.

A small pipe, usually 2 inches, is tapped into the suction line in each main oil compartment and led to the deck, with a valve. This is for the purpose of blowing through the oil piping, to remove oil or water standing in the pipes, and to clean them out.

Heater Coils

Certain oils are too heavy to be handled by the ship's pumps unless heated. This makes it necessary to fit heater coils in the oil tanks. A steam main leads from the boiler room, with branches and separate cocks for the various tanks. In each tank, the pipe leads to the bottom and extends fore and aft in several sections, about 200 to 300 feet in all. Several lengths are concentrated near the suction. The pipe then leads to the deck where it is advisable to fit a test cock, by the use of which the leakage of any oil into the coils can be detected. The return line then leads to an inspection tank in the engine room, and also to the atmosphere. It is found that the steam does not condense

* Concluded from the January issue.

in the line, but returns to the tank as steam, which would fill the engine-room if the usual non-watertight cover were used. It is therefore necessary to make the inspection tank entirely watertight, and fit a vapor pipe extending above the top of the engine casing. The inspection tank is piped to the hotwell, through filters, and also to the reserve feed tank in the double bottom. The heater coils should be well secured by hangers, and should be tested out with steam at the yard. This test should be made after all staging has been removed from the tanks, as it is quite possible that a stage-plank may be dropped on the piping and cause a break or a leak.

Valve Operating Rods

The operating rods for the valves in the oil piping inside the tanks form an important item. These may be of solid or hollow section in the tanks, but where they pass through the oiltight deck they must be solid, to prevent oil from leaking up through the deck. Also, where they pass through the stuffing boxes in the oiltight deck they must be perfectly smooth. These stuffing boxes should be of the gland and stud type. Two studs are sufficient, usually, but they must be calked. Stuffing boxes must be kept clear of seams or other riveting in the deck plating. The under side of the flange of the casting resting on the deck must be smooth and a good thick packing used. If the operating rods pass through a coal space, they must have guards to protect them from the coal. The guards consist of two 6-inch by 6-inch angles, toe to toe and extending from deck to deck, being fastened to the deck top and bottom by two clips each. Where the clips come on the oiltight deck they must be packed, calked and through-riveted, not tapped. If riveting is impossible, then the tops must have grommets and nuts under the decks. Clips should not be located over any deck rivets, but if unavoidable, the rivets should be flushed off. The clips should not be so located as to interfere with screwing the nuts on the gland studs. The angles are screwed to their clips by hex head tap-bolts.

Deck brackets have to be fitted at the upper end of the operating rods to support the hand-wheel. The bracket should be of cast iron with brass bushings and should extend at least two feet above the deck. The stuffing box and bracket can be cast in one piece. The hand wheel has no vertical travel, but the rod is usually fited with an indicator to show whether the valve is open or shut. This consists of a short threaded sleeve held from turning, so that it has a vertical travel on the rod. It carries a pointer which travels between spots on the bracket marked "open" and "shut." It is important that the pointer does not foul the gland studs, which would prevent the valve from closing. A fourteen-inch hand wheel is generally used, and all hand wheels should be marked with label plates showing what valves they operate.

If the lead of the rod is straight, it is quite easy to fit, although care must be taken in passing through the deck that it does not bind, due to the camber or sheer of the deck. It sometimes becomes necessary, however, to knuckle the rod, using universal joints. In any case, the rod should be vertical where it passes through the deck. It is not advisable to knuckle a rod at all, and in no case at a greater angle than ten degrees, as the rods bind badly when knuckled. It is considered wise to fit all operating rods with slip-joints, in order that they may adjust themselves to the deformation of the ship when in dry dock.

Vapor Pipes

The properties of the oil are such that it expands under heat and contracts when cooled, and gives off a vapor gas which also expands and contracts due to changes in temperature. To provide for this, it is necessary to connect the oil tanks with the atmosphere in order that the air and gas can escape when expansion occurs, and that a vacuum will not be formed if the oil contracts. A pipe is led from the top of each tank or from the hatch cover for this purpose. It usually extends about ten feet above the deck to carry the gas off clear of a man's head.

If the ship carries a very heavy oil only, and makes only a short run, or only carries oil from a warm climate to a cold one, it is satisfactory to fit a U at the top of the pipe and cover the open end with wire mesh to prevent sparks from entering. But if the ship carries light volatile oil on a long trip, the loss due to vaporization will be excessive, and it is necessary to fit an automatic valve at the top of the pipe, instead of the U. This valve is designed to lift at about five pounds pressure, in either direction; so that if the oil expands, the air and gas can escape as soon as the pressure reaches five pounds, or if the oil contracts air can enter the tank as soon as the pressure inside is five pounds less than that outside. The valves should be covered with wire gauze and should be examined frequently, as they have a tendency to corrode and stick, which might result in a dangerous pressure in the tanks.

The system works very satisfactorily for ordinary service, but there are certain ports where the law requires that these vapor pipes be carried thirty feet up the mast. In vessels using these ports, the practice is to connect the vapor pipes from all the tanks into two mains, which are carried up the masts so required, and terminate in the automatic valves. This makes all the tanks inter-communicating through these mains, which is undesirable, and therefore a stop-valve is fitted at each tank to shut it off from the main. This again is undesirable, for these valves should be closed when filling, and opened immediately after; and if anybody forgets, it will cause trouble. Also, if the automatic valves should stick, at a height of thirty feet, the pressure would be excessive. Thus the system of carrying the vapor pipes up the masts has many disadvantages, and should not be adopted unless required by the law, the individual vapor pipes for each tank being much more satisfactory.

If the ship burns oil, opinion differs as to whether vapor pipes are necessary from the fuel oil bunkers, but it is certainly safer to have them, unless the run is a very short one. These should be independent of the pipes from the cargo oil tanks.

Shore Steam

It is quite common, when docking at refineries to prohibit fires on board the ship. It is therefore necessary to supply steam from the shore, and the ship should be fitted for this purpose. Shore steam is required on the oil pumps, the deck winches, the heater coils, smothering pipes and ship's heating and cooking system, as well as in the engine room for the generators, and auxiliary pumps. Three shore connections should be provided, one for the oil pumps and deck use, one for the heater coils, and one for the engine room.

The deck connection should attach to a main from which the various systems are led. A short vertical pipe with a cross T should be fitted so that the hose may be attached with a straight lead from either side of the ship. A valve should be located on either end of the T, or the valve may be placed in the vertical pipe, in which case the end of the T opposite the hose must be blanked. The connection should not be placed too near a discharge casting or the steam hose will foul and burn the oil hose.

Smothering System

The smothering system in a tank ship differs from the

ordinary in that it has its main stop valve located in the boiler room, and has a separate cock at every tank. These cocks are required to be kept open when at sea. Thus, when the main valve is opened steam is admitted to all the tanks at once, and as soon as the fire is located all the cocks not required can be closed, localizing the steam to the tanks where it is needed.

In a shelter deck vessel, the United States Steamboat Inspectors are likely to require that these cocks be located above the shelter deck, rather than in the 'tween-deck. They also require the main valve and all the cocks to be fitted with label plates.

The smothering system is also used for steaming out the oil tanks for cleaning purposes, and while the smothering outlet is at the top of the tank the pipe should extend down nearly to the bottom of the tank, with a separate cock, for steaming out. The steaming out pipes may be attached to the heater coil system instead of the smothering system, however.

Drainage

In regards to drainage, it is important to note that no scuppers which drain any spaces into which oil might leak should lead into the engine or fire room bilges. In a shelter deck ship, if provided with tonnage openings to exempt the 'tween-deck space from measurement, the upper deck abreast the oil space must have shell scuppers. If without tonnage openings, the shell scuppers in this space should be omitted, except one at the after end, abreast the machinery space, which will not go through the oiltight deck.

Due to the fact that a tank ship will often trim by the stern when light and by the head when loaded, with fuel consumed, it may be advisable to fit a double set of scuppers in some of the quarters aft, one set in the after end and one in the forward end of the compartments, in order to drain in either direction. The shell longitudinals in the oil tanks should have large drain holes.

In some cases it is necessary to run the plumbing scupper or soil pipe from the midship deck house out through the summer tank to the shell. This requires special provision to insure oiltightness inside the tank. The ordinary lead soil pipe above the deck, usually four inch, connects to a cast steel scupper body on the upper deck; and inside the tank a six-inch extra heavy wrought steel pipe, lead lined, is fitted from the upper deck to a cast steel scupper body on the shell. These scupper castings are riveted and calked to the deck and shell, respectively, while at the upper deck the pipe joint bolts are fitted with trunkboard grommets under the heads and nuts. The flanges of the six-inch pipe to the shell scupper are riveted and calked.

The cofferdams should be fitted with suction pipes to the bilge pumps. It is sometimes required to carry water ballast in either or both of the cofferdams, and if so they are piped accordingly. It is also very useful to provide some system whereby any oil which leaks into the cofferdams can be pumped back into the oil tanks instead of being pumped overboard and lost. This can be done by means of the fire and bilge pump, taking the suction from the cofferdam, and discharging into the fire-main. By putting a valve in the fire-main on deck to close it off, an oil hose can be attached to a fire-plug and the oil pumped directly into an oil tank.

No paint whatever is required inside the oil tanks except that all faying surfaces should be coated with red lead and zinc. The oiltight hatches should be painted inside and out, however, after tank-testing has been completed. No painting should be done on the outside of the oil-space, such as the shell and upper deck, until the tanks are tested, if it can be avoided. The weather deck should be covered with an oil preparation, after the hose-test, which is required on a shelter deck vessel.

No cementing is done in the oil tanks, but the bottom of the pump-room and cofferdams should be cemented to facilitate drainage, and the cofferdams are generally cement-washed inside, throughout, provided they are used for ballast and not for fuel oil.

It is usually necessary to provide means of clearing the oil tanks of gas and steam before they can be entered. For this purpose, a fan is located in the pump-room and arranged to draw from the oil suction pipes and discharge into the air. By reversing the connection fresh air can be forced into the tanks through the oil pipes. It is also considered advisable to provide a gas exhauster for the pump-room itself. This can be accomplished by means of the fan, or by a special device consisting of perforated pipes in the pump-room leading to vertical pipes extending up through the deck with a steam jet led into them. A similar device may also be fitted to the deck discharge pipe, to remove gas from the pipe before connecting up for discharging.

Bleeders or docking plugs should be fitted to every main oil tank, also the pump-room and cofferdams. This should be located near the after end of each space. Sounding pipes should be provided for the cofferdams. The amount of oil in the main tanks can be determined in three different ways: first, by having marks put on the vertical metal ladders in the tank, so that the height of oil can be read and the corresponding volume found on the capacity plan; second, by inserting a batten and measuring the height of oil from the top of the tank and again referring to the capacity plan; third, by having a graduation batten in each tank which reads direct the volume of oil for any height. The latter method is decidedly preferable.

Every precaution must be taken against fire. Smoking is generally prohibited, and prominent signs placed to give warning against it in several different languages. No oil lights are used except in emergency; all the running lights are wired for electricity, and even the ruby distress lights should be provided with an electric cable and receptacle on the foremast. A spare generator should be carried so that electric lights can always be used. Lightning conductors are provided on the masts, consisting of a rod at each truck and a length of copper wire leading to the deck through insulators on the backstay; at the deck the wire is coiled on the pin-rail and the end can be thrown overboard in a thunderstorm.

Prices of Shipbuilding Materials Advanced in Japan.—There has been a general advance of 10 to 100 percent in the price of materials for shipbuilding since the last of August. Among the most important are steel plates, zinc, gas pipes, plate glass (thick), asbestos plates and iron wares, each of which has advanced 50 percent; steel bars have increased 70 percent, and lead, tin and plate glass (thin), 100 percent.

Japanese Transpacific Line.—Announcement is made in Manila that the Nippon Yusen Kaisha will put three of its new steamers on the Hongkong-Europe run. These three vessels will be the *Ysaka Maru*, *Suwa Maru*, and the *Fushimi Maru*, of which the first named was scheduled to leave Hongkong November 18. These new steamers have a gross tonnage of 12,000 and a displacement of 21,000 tons each. Their cargo capacity is 14,000 tons and their speed 17 knots each. There are accommodations for 122 first class and 60 second class passengers. The vessels are very modern in construction and are well equipped with safety and convenience and comfort devices.

Dyson Chart System of Propeller Design

Calculation of Total Effective Horsepower—Application of Dyson Chart to Triple Screw Battleship

BY JAMES S. MALSEED

There have appeared at different times in this publication references to the Chart System of Propeller Design by Captain Charles W. Dyson, U. S. N. The writer wishes to show one of the many possibilities that can be accomplished by the use of this system.

When a vessel is moved through the water at a given speed it requires a certain effective horsepower to propel the vessel at this given speed. The propeller must deliver this effective horsepower. The model tank has been used to advantage to determine the necessary effective horsepower, and from the powers found by model tank experiments engineers have fixed the necessary indicated horsepower or shaft horsepower to deliver this effective horsepower. I have never heard, however, of any one who would calculate the effective horsepower from the actual indicated horsepower or shaft horsepower determined under actual conditions. With the "Dyson" method this calculation becomes a very simple operation.

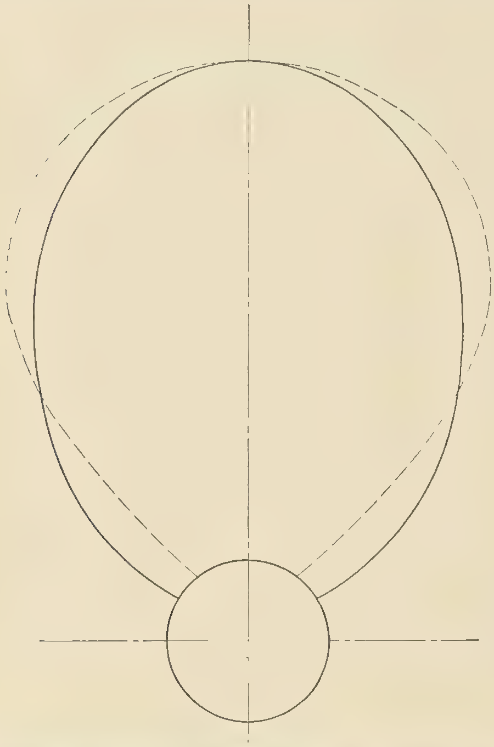


Fig. 1.—Solid Line Shows Actual Blade Form. Dashed Line Shows Dyson Standard Form

Calculation of Effective Horsepower Delivered by the Screw

To calculate the effective horsepower delivered by any given wheel, acting behind a given vessel, it is first necessary to estimate the chart wheel complement of the given screw. The necessary information required is as follows: Diameter, pitch, projected area ratio and the form of the projected area. The characteristics of the vessel are also necessary, such as length between perpendiculars, beam immersed, block coefficient, coefficient of immersed mid area and the shape of the different waterlines of the after body of the vessel. With the above data and a curve of results from a standardization trial of the vessel or the data for any certain speed, the effective horsepower can be calculated for that certain speed or with the curve of performance given, the effective horsepower can be calculated throughout the *whole* range of speeds given.

The estimate of the complementary chart wheel to the given wheel is made by laying down the given wheel to its exact projected area form. Then, through arcs drawn to tenths of the radius, each arc is compared to the "Dyson" standard blade form of projected area and the mean is taken as the projected area of the given screw to use with the charts. In this estimate the outer third of the blade is considered to have twice the influence of the inner two-thirds of the blade.

Applying this projected area ratio, together with the standard block coefficient and thrust deduction factor found on the charts for the given vessel, the pitch and diameter being the pitch and diameter of the given wheel, the different values of indicated horsepower, or shaft horsepower, effective horsepower and speed, are then calculated from the charts for a *chart wheel* working under chart conditions for this particular projected area ratio.

The effective horsepower is then found for any given speed from the formula—

$$dehp = \sqrt[x]{\frac{IHP_d}{IHP \times \left(\frac{v_d}{v}\right)^{3.5\,(1-x)}}} \times DEHP$$

where, $dehp$ = effective horsepower of the vessel,
$DEHP$ = effective horsepower (chart condition),
IHP_d = indicated horsepower from trial result,
IHP = indicated horsepower from chart condition,
v_d = speed of vessel corresponding to IHP_d,
v = speed chart condition.

The exponent x is found from the "Dyson" charts.

It will be noticed from the above that there are three distinct estimates to make, namely, projected area ratio, chart block coefficient and the trust deduction factor, but even with the many chances for error in estimating these values the results obtainable are remarkably close.

Example

As an illustration of how closely the effective horsepower may be calculated, an example is given of a battleship which recently finished her official trials. The vessel has triple screws, 13 feet 6 inches diameter, 10 feet pitch, and an actual projected area ratio of .508. The propellers are three-bladed. As the vessel has three screws, the wing screws must be calculated separately from the center screw and the sum of *twice* one wing and the center is taken as the total for the ship, as the wing and center screws are working under entirely different conditions.

In the example under consideration, the chart block coefficient for the wing screws is .602, while the block coefficient for the center screw is .72, and the thrust deduction factors are 1.012 and 1.082, respectively. The estimate of the complementary chart wheel shows a projected area ratio of .434. This is due to the narrow tipped blade fitted to the wheel.

Fig. 1 shows the difference of the projected area form of the actual wheel fitted and the chart wheel of the same projected area ratio as the actual wheel. The calculations

for the chart wheel, working under chart conditions, with a projected area ratio of .434, give the following results:

	Wing	Center
SHP	8325	7282
DEHP	5330	4360
Speed-knots	18.172	18.724

Fig. 2 shows the curves of actual shaft horsepower for the wing and center screws plotted separately. It will be noticed that the center-screw curve shows the characteristic hump of a screw working behind a stern port like a single-screw vessel. The curve marked *EHP*, towed model, is the effective horsepower of the ship from the towed model at a constant displacement on even keel. The curve marked estimated *EHP* is from the calculations of the effective horsepower delivered by the screws.

It will be noticed that at the speed of 12 knots the curves of the towed model and the calculated *EHP* exactly coincide. At 15 knots there is a difference, at 19 knots they almost meet, and at 22 knots they separate again. The variations in the calculated curve from the towed model curve prove the correctness and also the usefulness of the calculated curve, for the reason that from the drafts taken on trial the vessel showed 300 tons under the displacement of the towed model at 15 knots and the same condition at 22 knots, while at 19 knots the vessel had 13 tons more displacement than the towed model.

The calculated curve thus shows absolutely the condition under which the vessel was working at the different speeds. The actual difference between the two curves at 19 knots is about 110 *EHP,* while the towed model curve shows a total effective horsepower of 10,900 for this speed. The difference is just about one percent, or as close as the towed model curve itself can be to the actual effective horsepower necessary to drive the vessel at this speed.

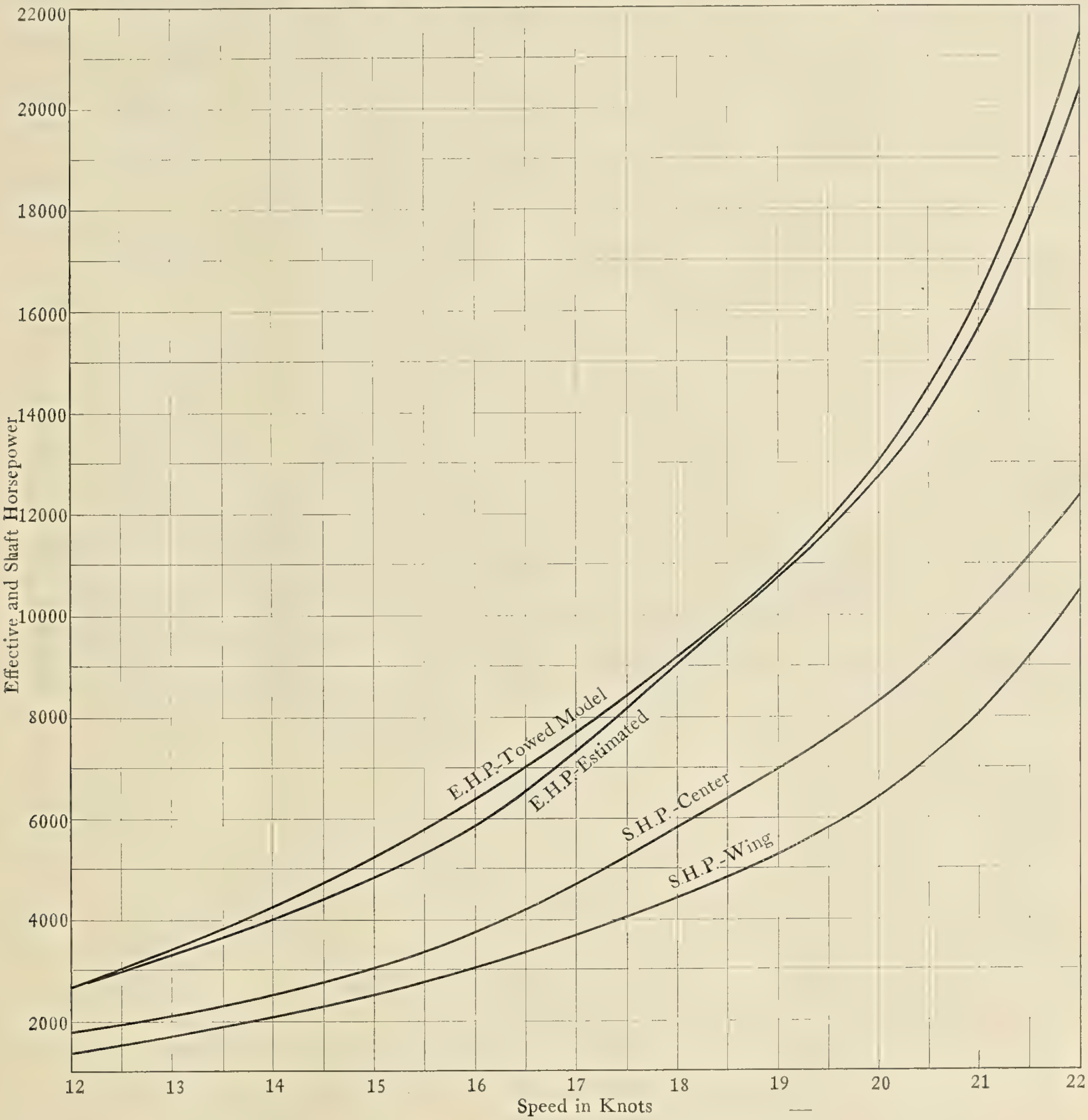


Fig. 2

This shows conclusively the remarkable work that can be accomplished with the "Dyson" charts.

SUPERIOR SHIPBUILDING COMPANY.—The Superior Shipbuilding Company, Superior, Wis., for twenty years an important factor in the shipbuilding business on the Great Lakes, has given up ship construction and hereafter will devote its attention to repair work.

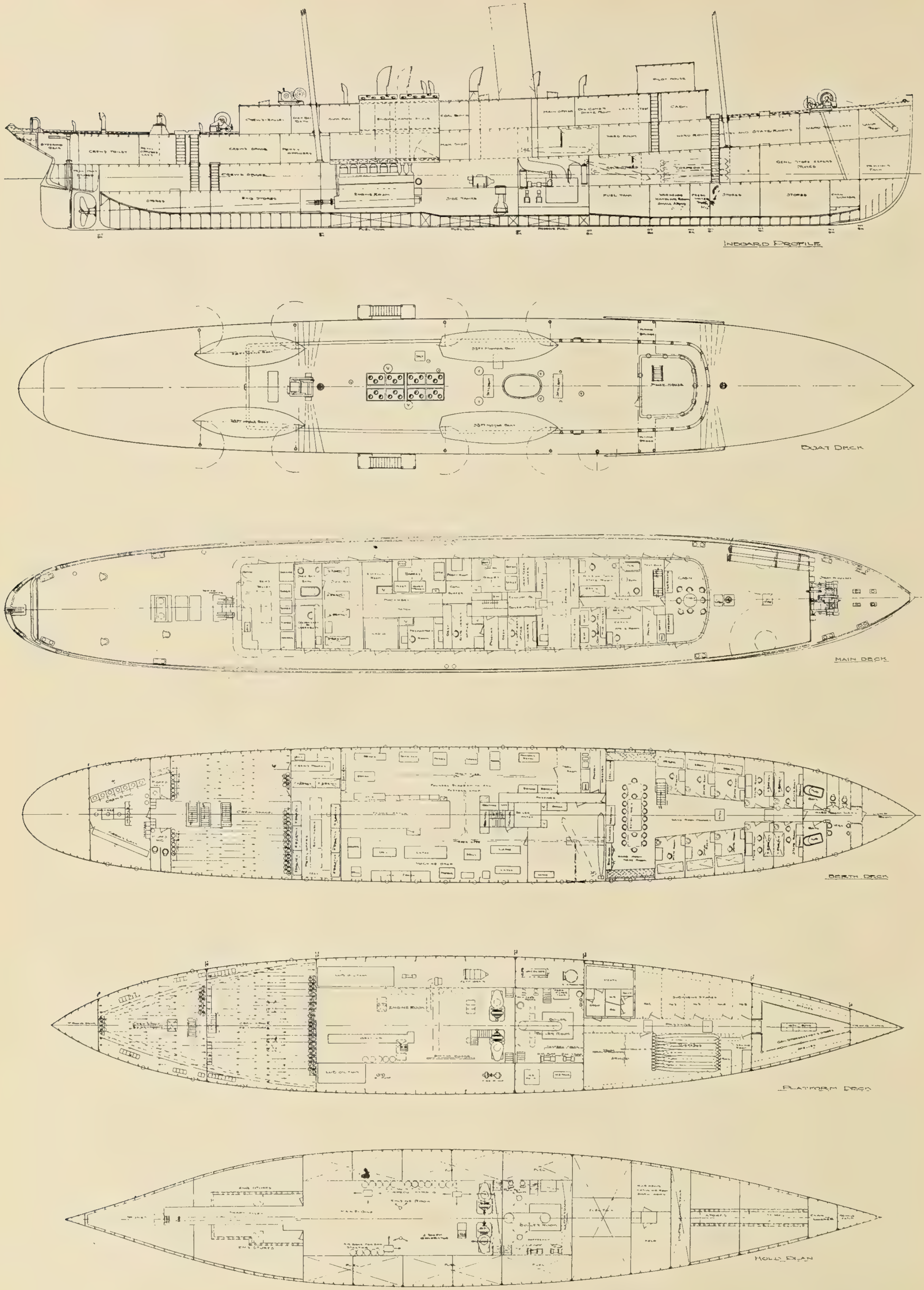


Fig. 1.—Profile and Deck Plans of the *Fulton*

Trials of the Submarine Tender Fulton

First United States Naval Vessel to be Fitted with Diesel Engines—Contract Speed Exceeded by One-Half Knot

On October 31, 1914, the United States submarine tender *Fulton,* built according to plans developed by the New London Ship & Engine Company, Groton, Conn., working jointly with the firm of Cox & Stevens, naval architects, New York, was given her official tests by the U. S. Naval Board of Inspection and Survey for Ships. The vessel was first standardized over the Provincetown course, five different runs at varying speeds being made. The highest speed attained was 12.78 knots, corresponding to 259.4 revolutions per minute of the propeller. The guaranteed speed was 12.25 knots, thus showing that the ship exceeded her guarantee by one-half knot.

A complete description of the *Fulton* was published on page 285 of our July, 1914, issue, and a description of the shop tests of her main engine on page 510 of our November, 1914, issue. The hull was designed by Cox & Stevens and the machinery by the New London Ship & Engine Company, who built the machinery and sublet the contract for the construction of the hull to the Fore River Shipbuilding Corporation, Quincy, Mass.

The principal dimensions of the vessel are as follows: Length overall, 226 feet 6 inches; length on waterline, 216 feet; beam, molded, 35 feet; depth, molded (to upper deck at center line at one-half length), 24 feet 3 inches; draft, trial load, 12 feet 11½ inches; complement (officers and crew), 190.

The vessel has a complete upper deck, a complete berth deck, platform decks at the end and a double bottom. The general arrangement is shown in the accompanying plans. The main engine is a vertical, inverted, two-cycle, single-acting, air-starting and air-reversing Diesel engine of the Nlseco type. There are six working cylinders and two air compressors, the aggregate power developed being about 1,000 at 260 revolutions per minute.

The standardization trials were followed by anchor tests and maneuvering trials. With the ship running full speed ahead, the signal was sent to the engine room to reverse. The time required to reverse the engine was twelve seconds. The time required to bring the ship to a dead stop in the water was forty-five seconds. Other maneuvering trials, such as the determination of turning circle, maneuvering of helm under various conditions, etc., were also carried out with most satisfactory results.

These trials were followed by a four-hour test at a cruising speed of 11 knots. The object of this test was to determine the amount of fuel used both by the engine and by the boiler, the latter being for auxiliary purposes. The speed made during this trial was 11.09 knots. The boiler used 37.8 gallons of fuel per hour, while the engine used 47.3 gallons per hour. During the test the following auxiliaries were in operation; turbo-generator, electric lights, ventilation, sanitary pump, fuel oil pump, evaporator, fresh water distiller and circulating pumps, ice machine and the pumps for main engine.

On November 1 the eight-hour full power test was made. The guaranteed speed was 12.25 knots. The average speed for the eight hours was 12.35 knots, the average revolutions per minute being 249.49. The average fuel consumption of the engine was 66.72 gallons per hour

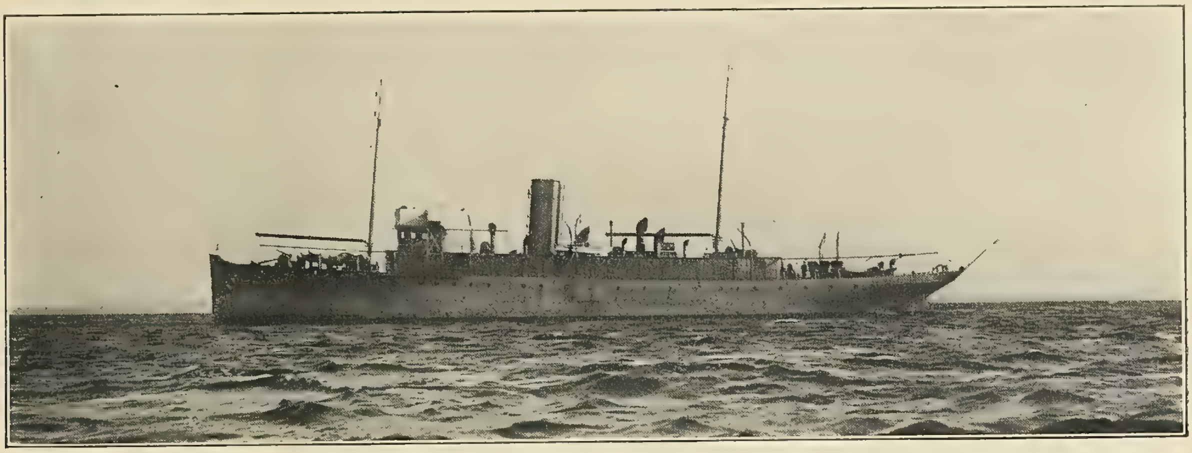


Fig. 2.—Diesel-Engined Submarine Tender *Fulton*

The boiler consumption was 23.31 gallons per hour. Fuel oil was used having a density of 31° Baume.

During all the above-mentioned tests the performance of the engine was said to have been perfect. At no time was the engine shut down, nor was there the slightest evidence of undue heating, unusual noise or other derangement. In view of the fact that this is the first large Diesel engine to be built in the United States and installed in a large ship, the performance is regarded as highly satisfactory.

With the amount of fuel carried in the ship, it would be possible for her to cruise a total distance of at least 10,000 miles. The fuel consumptions above indicated show that as compared with the fuel consumption of a steam vessel the *Fulton,* on a given amount of fuel, could travel four to five times the distance that a similar steam-driven vessel could travel. The saving in fuel bills is obviously a big item. There is also a great saving in the number of men required to operate the machinery. Adding together the saving in fuel, in personnel, and the gain in extra carrying capacity or increased radius, the commercial advantages due to the use of heavy oil engines at once become apparent.

In the *Fulton* the double bottom spaces are utilized to carry fuel oil and reserve feed water. The hold contains fuel oil tanks, storerooms and an ammunition room. On the platform deck are storerooms and a torpedo magazine

forward and the crew's space aft. Over the engine room on the berth deck is a machine shop, with a torpedo testing room immediately forward. The deck house contains the galleys, bakery, wireless room, sick bay, and various offices.

On account of the peculiar requirements of the service for which the vessel is designed, the outfit of auxiliaries is rather more extensive than is customary. The anchor windlass, steering engine and towing machine require no further notice than to mention that they are of the usual steam-driven types, steam being furnished by a donkey boiler. The electrical equipment consists of two independent installations—a turbo-generator for lighting the ship and furnishing power for auxiliary motors, and two large generators coupled to the main engine, primarily intended for charging the batteries of submarines. The two latter are located on the same fore and aft line as the main engines, and immediately forward of them.

There are also two types of air compressors, two high-pressure compressors driven by electric motors for charging the ship's or submarine's air flasks and torpedoes, and a 100-pound steam-driven compressor for supplying air for pneumatic tools.

The machine shop is equipped with the necessary lathes, drill presses, shapers, milling machines, etc., for making usual routine repairs on submarines. In addition, the foundry and blacksmith shop contain a furnace and a blacksmith and foundry outfit. Cargo ports are arranged through which torpedoes may be passed into or out of the vessel.

New Sea-Going Steel Tug

The steel tug *Bristol*, illustrated in Figs. 1, 2 and 3, was recently designed and built by the Staten Island Shipbuilding Company, Port Richmond, N. Y., for the Staples Transportation Company of New York and Boston for towing coal barges. This is the six hundred and thirty-sixth vessel built by the Staten Island Shipbuilding Company, and is a splendid specimen of the type of towboat for which this firm is noted. The *Bristol* is 125 feet long overall and 120 feet 3 inches long between perpendiculars. She has a molded beam of 24 feet 6 inches and a molded depth of 15 feet 6 inches at the lowest point of sheer.

Fig. 2.—Sea-Going Tug *Bristol*

The hull is of steel throughout with the exception of the pilot house and the captain's quarters, which are of wood. The steel deck house is arranged to provide for the officers' mess and galley, a companionway to the fore-

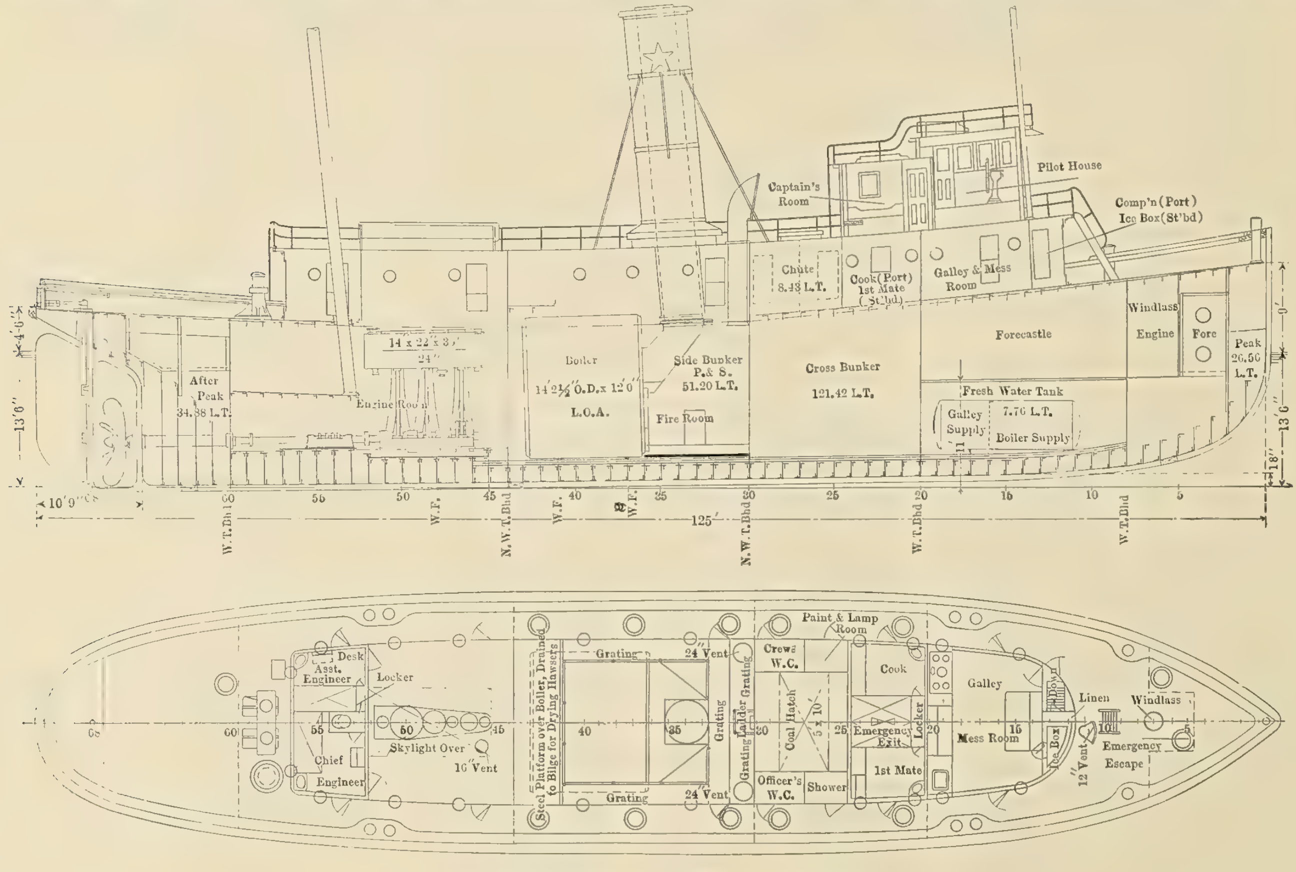


Fig. 1.—Profile and Deck Plan of the *Bristol*

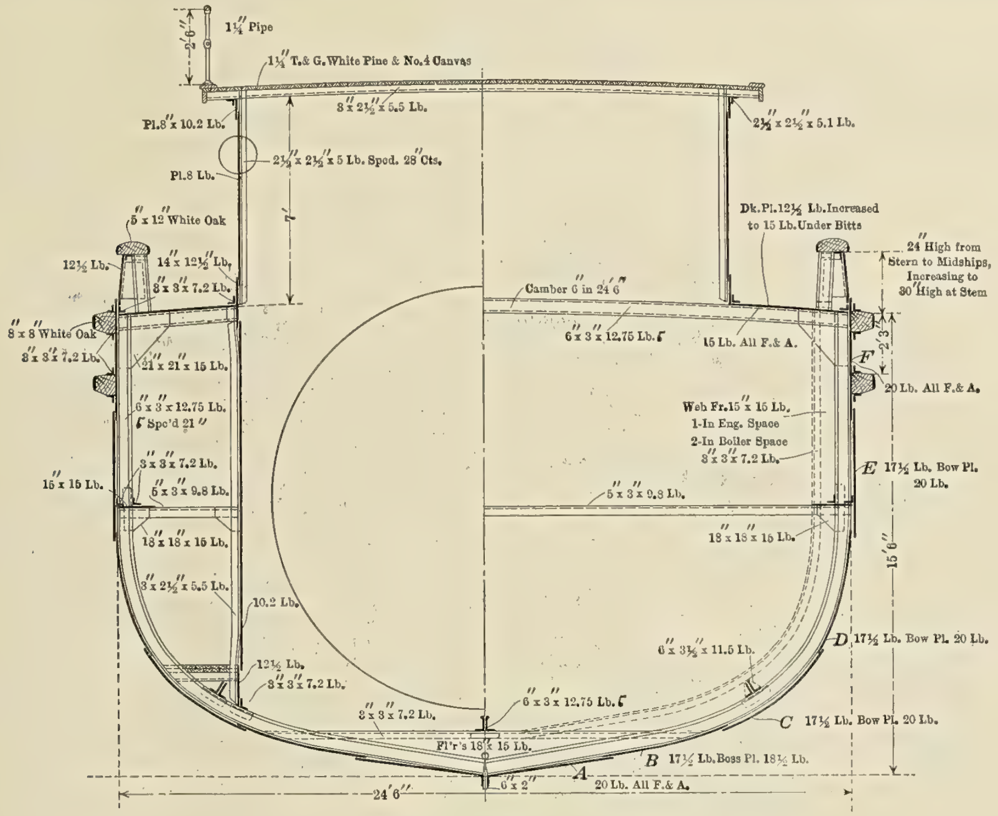
castle, rooms for the chief and assistant engineer, mate and steward and also for the toilet, lamp and hawser rooms. The crew's quarters are below, forward of the machinery space. Large feed water tanks are provided in the forward and after peaks, with a cross bunker forward of the boiler. The tug is rigged with one wooden pole mast.

The principal scantlings of the hull are shown on the midship section, Fig. 3. There are three watertight bulkheads, one at each end of the boat and one forward of the coal bunker. Two non-watertight bulkheads are fitted, one forward of the engine and one forward of the boiler, the latter forming the athwartship coal bunker. Both of these bulkheads extend to the sides of the ship.

link motion with double bar links. The engine is fitted with a hand-turning gear and a steam reversing gear and exhausts into an independent condenser of circular section with about 1,000 square feet cooling surface. The air pump, made by the Staten Island Shipbuilding Company, is driven off the main engine.

The crank, thrust and propeller shafts are all 8 inches in diameter. The crank shaft is of the built-up type with cast steel webs and wrought steel pins. The propeller shaft is a mild steel forging with composition sleeves shrunk on the shaft.

Steam is supplied at a pressure of 185 pounds per square inch by one Scotch boiler, 14 feet inside diameter and 12 feet long over the heads with a total heating surface of



Fig| 2.—Midship Section

The keel is a 6-inch by 2-inch rolled steel bar, fitted in long lengths connected by 20-inch planed scarfs. The stem is of the same size and quality material, while the stern frame is of the best hammered scrap iron in one piece, both the propeller post and rudder post being 6 inches by 3 inches. The frames are 6-inch by 3-inch by 12.75-pound bulb angles spaced 21 inches apart, extending from the keel to the deck. Intermediate ice frames consisting of 5-inch by 3-inch by 9.8-pound angles are fitted from the stem to about 30 feet aft of same, extending from 2 feet below the light-load line to 2 feet above the deep-load line. Two web frames of 15-pound plate 15 inches deep are fitted in the boiler space and one in the engine room.

Propulsion is by a vertical, inverted, direct-acting, triple expansion engine with cylinders 14 inches, 22 inches and 36 inches diameter with a common stroke of 24 inches. The cranks are set at 120 degrees and the sequence of cranks is high-pressure, low-pressure and intermediate. The high and intermediate cylinders are fitted with piston valves and the low-pressure cylinder with a double ported slide valve, all of the valves being worked by Stephenson

about 2,400 square feet and a grate area of about 72 square feet. There are three Morison corrugated furnaces 44¾ inches inside diameter leading into a common combustion chamber. The boiler is operated under natural draft.

The auxiliaries include the usual feed, bilge and sanitary, donkey and boiler circulating pumps. All of the pumps are of the Blake type, with the exception of the air and circulating pumps, which were made by the Staten Island Shipbuilding Company in accordance with their special design. A Reilly feed water heater is installed. The electric current for lighting the vessel is supplied by a Sturtevant machine with a capacity of 5 kilowatts at 110 volts.

The *Bristol* is a first class sea-going tug and is equipped with every modern device for safety and ease of handling in the service for which she was designed. Her bunkers have a capacity of 200 tons of coal and she carries 70 tons of fresh water in her tanks. Captain Ezra N. Hammond is in command of the tug and Herman Kampler is chief engineer.

Congestion of Freight at New York Piers

Inadequate Facilities and Lack of System Cause Confusion and Wanton Waste of Time in Handling Freight at Marine Terminals

Package freight moves through the New York terminals in quantity and variety greater than through any other terminals in the United States. To cope with this situation, the freight terminals must either be spread over a wide area or else conducted with an efficiency of the highest order. Although the operating area of the New York city terminals can be increased somewhat without even double-decking them, these terminals are quite inelastic so far as area is concerned; therefore that elasticity, which is as essential in operating a terminal successfully as it is in operating any other business, is to be had largely through efficient operation.

In the New York city terminals under the present conditions, efficiency of the highest order in operation must be had. Anything less must shortly prove intolerable, and as a result commerce will seek routes less choked by which it can move in a fluid state and not in compressed masses. In the movement of package freight through New York terminals, the pre-eminent factor is celerity. Any methods which permit celerity of movement and increase the volume of freight moved in a given time should immediately be installed. To discover a method and to put into operation a plan whereby the business of the freight terminal can be speeded up and the volume of the freight increased is to discover a solution of the terminal problem.

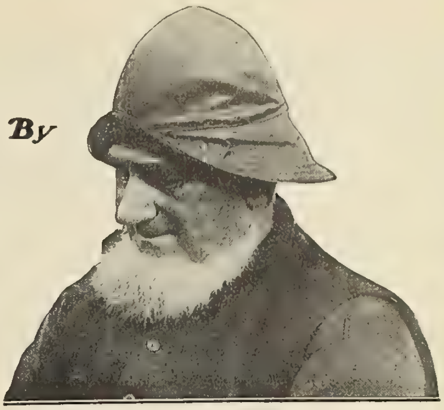
Such a solution must bear a direct relation to transportation as a whole, for the efficiency of any line of transportation in a great measure is limited by the adequacy of the terminal facilities and the speed with which they can be operated. No line of transportation can be more efficient than its terminal facilities permit it to be. In spite of this we look in vain for the application of engineers' skill to the improvement of terminals. It is true that valuable suggestions have been made at frquent intervals in different places, but too often these suggestions have found their way into the scrap heap untried. With a few exceptions, freight terminals in New York city and their management remain substantially the same as they were twenty-five years ago. In almost every case they stand, no matter of how recent construction, a monument of the days of manual labor, equipped with meagre appliances of a generation ago, with methods unchanged, charged with the titanic labors that accompany the building up of one of the greatest commercial centers of the world.

Congestion Along West Street, New York, in Front of the Steamship Piers

Congestion at the terminals is due in part to the volume of freight moved, but much more to internal confusion in the terminals, resulting from inadequate facilities and lack of system, which cause wanton waste of time both within and without the terminal itself. A freight terminal means the provision for proper contact between the shipper and carrier, and between the carrier and consignee, and thus the duty of a transportation company to provide proper freight terminal facilities is a public one. When the transportation company cannot get sufficient terminal space, then it must improve its terminal methods.

Freight terminals are equipped in some cities with telpherage systems, moving tracks, electric trucks and many other mechanical appliances for the quick handling of freight. Why should not the terminals in the greatest city in America be given equal facilities?

Economy Talks By "Old Scotch"



Possible Savings with Oil Fuel

In these days when you are looking for economy everywhere, even to cutting down your missionary contributions, it might be a good idea for marine engineers to look into the proposition of burning fuel oil instead of coal. As I said in my first article, most of the economy on ships has got to come from the fireroom, so this oil business offers a pretty good field for saving.

The point where it will pay to switch from coal to oil is not so hard to determine as you might think, and it will depend principally on where you are located whether you should make the change or not. For instance, if you are running out of a port where coal can be purchased for $3.50 (14/7) a ton, and oil costs you $2.25 (9/4½) a barrel, you'd better study how to get the most you can out of your coal, and forget all about oil. Some folks say that three barrels of oil are as good for steaming purposes as one ton of coal, but I don't find it so in my experience with oil burning, and I have had some experience, if I am somewhat over sixteen. As a general proposition you will find that about four barrels of oil are a fair equivalent to one ton of the average coal. Now if you can get oil at $1.25 (5/2½) a barrel and your coal costs you only $4.50 (18/9) a ton, don't be too sure that it will not be economy to use oil, even if four times $1.25 (5/2½) does make $5.00 (1/0/10).

There are other things to be considered beside the exact costs of oil and coal. Remember that with oil you don't need any shovels: a fireman on an oil burner can stand his watch, or even "sit" a watch with a white shirt on and have time to pick his teeth occasionally. No coal to shovel in and no ashes to haul out make the labor part mighty easy, so the result is that you can cut your fireroom force right in half. I know of a steamer converted from coal to oil, on the Pacific, which used to have an engineer's crowd of 36 men that is now getting along with just 19 men, and none of them killing himself with work, either. The reduction of the wages of these men, their grub, cook's wages, etc., amounts to about $850 (£175) a month. That will offset a considerable increase in the cost of oil over coal.

And the saving in wages is not the only one you get from such a change. There will be less repairs to the boilers, no monthly charge for new grate bars, furnace liners, and things of that kind. You will have extra cargo space, as the oil takes up less room than coal; there will be a saving of soap and elbow grease on account of not having to clean up after frequent coalings; a saving in time of fueling and in not having any ashes to dispose of in port or at sea. In fact it is hard to tell all the savings you do get from the use of oil. Anyhow it is a safe bet that it will pay you to use oil, as a general proposition, even if four barrels of that fluid costs you 25 percent more than one ton of coal.

Of course the expense of installing the necessary tanks to carry the oil in is a serious one, and in many cases prevents the use of oil fuel on old vessels. There are a great many old vessels, however, on which a limited stowage capacity of oil can be installed without such a great cost. For example, on harbor boats and on steamers making comparatively short runs between ports, it is only necessary to carry four or five days' supply; as it is an easy matter to take the oil on board the frequency of fueling does not make so much difference. In cases like this, stock tanks can be bought and installed in the coal bunkers at a very small cost. I know of one good-sized tugboat which carries a week's supply of fuel in ordinary hot water tanks such as are made to hitch onto the kitchen stove in a plain $30 (6/5/0) a month brick house. These small tanks were tested to 200 pounds pressure and of course are absolutely oil tight. The cost of the tanks and connecting them up in place was only a little over $400 (£82) so you see that this expense needn't scare anybody off who is satisfied with a limited supply of fuel oil. On this tugboat the cost of the oil pumps, heaters, filters, etc., complete was only $1,200 (£246). That made the total cost of the oil installation a little more than $1,600 (£328). This particular tug is doing business at a port where coal is $5.50 (1/2/11) per ton and oil is 80 cents (3/4) a barrel. The saving in fuel alone compared to what was paid for coal was over $2,000 (£410) the first year the scheme was tried. That's pretty good percentage of saving for a first cost of $1,600 (£328) or so!

I don't know whether many of you have ever bothered to hunt up the right kind of a burner to shoot the oil through. If you have I guess you will come to the same conclusion that I did. That is that the right one isn't made yet. However, almost any of them will work fairly well. I think the Patent Office records will show that there have only been a little over four hundred thousand patents, more or less, issued on oil burners, and that they are running our old friend the car-coupler a close record for the Patent Office handicap.

There are several methods of burning oil on board ship, but practically speaking there are only two used. The greater number of oil-burning vessels are fitted for steam atomization, although there are some fitted for mechanical atomization. The object of both methods is to take fuel oil and shoot it into the furnace in as fine a spray as it is possible to get, something like the way the barber shoots perfume over you just before he puts out his hand for the tip you are about to hand him, after you are all dolled up.

With proper burners, properly handled, oil can be burned without a sign of smoke. When you are looking for economy on your particular ship don't forget to look into the oil question.

Yours for economy,

Old Scotch

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Q.—Will you kindly explain the essential difference between reaction and impulse turbines and what is meant by a compound pressure and compound velocity turbine? I. V.

A.—Steam turbines are essentially mechanisms in which the velocity of the jet or jets is utilized to produce rotation of vanes. Velocity is produced in a steam jet only

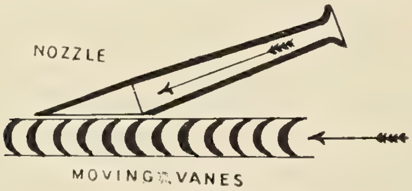


Fig. 1.—Sample Impulse (DeLaval)

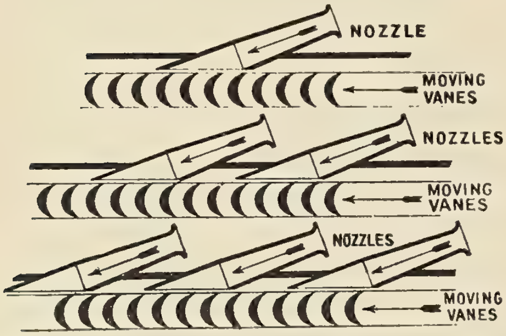


Fig. 2.—Pressure Compounding (Rateau, Zoelly and Hamilton-Holzwarth)

by expanding from one pressure to a lower pressure, so that regardless of the type of turbine there must always be a pressure drop to generate the velocity which is utilized. The velocity imparted to the jet may be utilized in two ways: (1) By impinging on a vane and driving that vane by impulse; or (2) by driving backwards the nozzle in which expansion has taken place owing to the reaction, or "kick-back," of the steam in coming to a high velocity from a low one by expanding through the pressure drop. No. 1 is basic for impulse turbines and No. 2 for reaction turbines. If a large pressure drop is available, this means a high nozzle velocity, and in some cases it is difficult to utilize efficiently a high velocity, so recourse is had to making the pressure drop occur a small amount at a time, each drop in pressure and attendant increase in velocity being but a fraction of the overall drop; this is known as pressure compounding. (See Fig. 2.)

The same result may be obtained by accepting the high velocity due to a large pressure drop and arranging several rows of vanes so that each row takes out a certain fraction of the velocity of the jet; as, for example, if a pressure

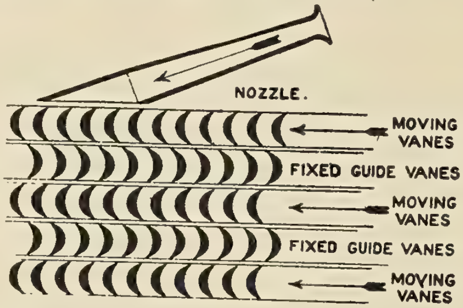


Fig. 3.—Velocity Compounding (A. E. G. (Small), Electra and Terry)

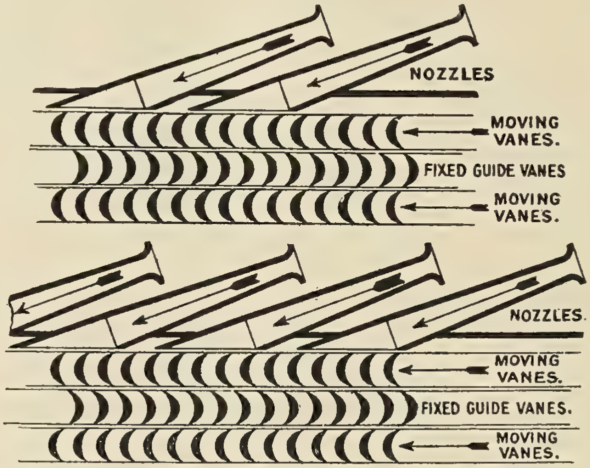


Fig. 4.—Pressure Compounding with Velocity Compounding (Curtis Marine Type and large A. E. G.)

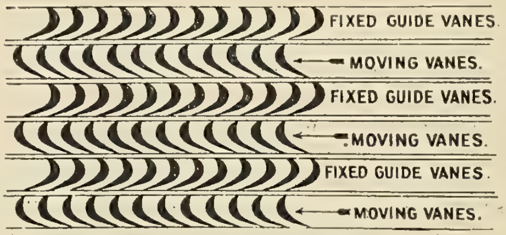


Fig. 5.—Reaction (Parsons)

drop of 150 pounds gives a nozzle velocity of 3,600 feet per second the peripheral velocity of one row of vanes to utilize all of it would be 1,700 feet per second, but if there were four wheels, the velocity of each would be but one-fourth of this, or 425 feet per second. This is called velocity compounding. (See Fig. 3.) Frequently both pressure and velocity compounding occur in one turbine, as, for example, the Curtis type, where the turbine as a

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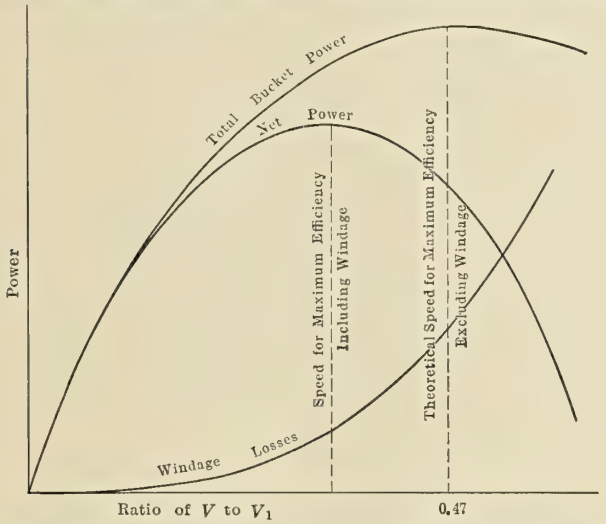
whole is of the compound pressure type with each pressure stage of the compound velocity type. (See Fig. 4.)

There are no turbines of the pure reaction type in common commercial use, but an example is the much illustrated toy of Hero consisting of a sphere with steam under pressure, which is caused to rotate by the reaction, or "kick-back," of two steam jets inserted into it with their discharge axes at right angles to the axis of rotation of the sphere. The turbine most commonly classed as of the reaction type is the Parsons (see Fig. 5), in which there is a small pressure drop in the first row of vanes, the reaction from which tends to cause the vanes to rotate away from the direction of discharge. Though called vanes, these are in effect nozzles, as there is a pressure drop and velocity increase taking place in them. In the next row the same action takes place, but these vanes being fixed, the jet impinges against the following rows of moving vanes which feel the compound effect of this impulse and the reaction due to the further expansion through the second moving row. This cycle is repeated throughout the rest of the turbine.

Q.—In the design of a steam turbine of the impulse type is it possible to calculate the speed of the vanes which will give the best steam economy, or is this desirable speed determined from tests? T.

A.—The speed of rotation of a steam turbine wheel, neglecting friction and windage losses, in order to give maximum efficiency, is only a function of the velocity of rotation, and angle and velocity of the jet. If V_1 is the



Plot Showing How Windage Losses in High-Speed Turbine Wheels Affects Choice of Desirable Peripheral Velocity

absolute velocity of the jet, and V is the velocity of rotation of the vanes and α is the nozzle angle, then the efficiency is the ratio of the work done to the energy delivered by the jet. The work done is the impulse times the distance through which it moves. Work $= \frac{W}{g} V_1 \cos\alpha \times V$, if there is to be no velocity of whirl on leaving the vanes. The kinetic energy of the jet is $\frac{WV_1^2}{2g}$, so that the efficiency is $2 \frac{V}{V_1} \cos\alpha$. If we make the efficiency a maximum of unity then $V = \frac{1}{2} V_1 \cos\alpha$, which is the theoretical vane velocity to give maximum efficiency, neglecting frictional and windage losses. For a nozzle inclined at an angle of 20 deg. to the wheel, $\frac{1}{2}$ cos 20 deg. = .47 and $V = .47\ V_1$. In order to further reduce vane speed, more than one row of vanes is frequently utilized in a stage. This reduces the peripheral velocity of the vanes in direct proportion to the number of rows used, so that the factors for V for two, three, or four rows become 24 percent, 16 percent and 12 percent, respectively, of V_1, using 20-degree nozzles. In practice neither the frictional nor the windage losses can be neglected, and for single-wheel turbines, as used on land practice, the windage losses become the dominating feature in the choice of a proper vane speed, as may be seen from the accompanying sketch. In the marine type, however, which uses two or more rows of vanes to each stage and much lower revolutions per minute, the windage losses are a much smaller percentage of the total losses, and the factors given above, when corrected for frictional losses in the vanes, may be used. The correction for friction through the vanes is a geometrical one, and if the loss be expressed in terms of the heat available for producing velocity, and represented by y, the velocity of discharge is equal to

$$V = \sqrt{2gh(1 - y)}.$$

For various values of y the following table* holds:

VANE SPEED IN PERCENTAGE OF JET SPEED

LOSS FACTOR Y	.04	.08	.12	.16
Stage of one wheel	47	46	46	45
Stage of 2 wheels	24	24	23	23
Stage of 3 wheels	16	15	14	13
Stage of 4 wheels	12	11	10	09

* From Steam Turbines, by C. H. Peabody.

Q.—Is there any way for readily determining the helicoidal and projected area from a propeller in place on a ship? H. H.

A.—The best way of obtaining the helicoidal or developed area of a propeller wheel from the propeller itself is to stretch a large piece of ordinary brown manila paper smoothly over the acting surface of one blade and press it down around the edges to get the contour. Trim the paper to this crease and measure the area by taking the breadths at equal intervals and summing by the trapezoidal or Simpson rule. If the former is used, and one breadth is located at the extreme tip, the area is the sum of half the tip and hub breadths plus all the others multiplied by the distance radially between successive breadths. The projected area may readily be determined from the developed area with a reasonable amount of accuracy by either of these two formulæ; the first proposed by S. Barnaby and the second by D. W. Taylor:

(1)
$$\text{Projected } A = \frac{\text{Developed Area}}{\sqrt{1 + 0.425 \dfrac{\text{Pitch}}{\text{Diameter}}}}$$

(2)
$$\text{Projected } A = \text{developed } A \left(1.067 - \frac{0.229 \text{ Pitch}}{\text{Diameter}}\right)$$

No. 1 becomes inaccurate if used for pitch ratios (pitch ÷ diameter) and much different from 1.0. No. 2 is expected to hold over a range of pitch ratios from .6 to 2.0, which is all that is customarily met with.

Q.—Are there any simple tests for lubricating oils which the operating marine engineer can undertake which will help him to decide upon the best oil of the many commercial oils presented for his purchase? L. B. C.

A.—It is probably impossible to obtain complete information about any oil outside of a well-equipped laboratory, but there are several important characteristics of the ordinary mineral lubricating oils which can be determined without much apparatus. These are: (1) specific gravity; (2) flash point; (3) gumming; (4) acidity, and (5) adulteration with animal or vegetable oils. A trial of

these tests will usually permit an engineer to select for himself the best of several samples of oil submitted.

No. 1 is determined by the common Baumé hydrometer directly, as the mineral oils are usually designated by the Baumé scale. (The true specific gravity may be found by the formula $\frac{141.5}{131.5 + B^\circ}$, where B° represents the reading Baumé.) No. 2 can be determined by heating some of the oil in a porcelain dish until a puff of flame goes over the surface of the oil, and by noting the temperature at which this occurs. No. 3 is determined by thoroughly mixing and heating together 5 grams of oil in a cordial glass or wide-mouthed bottle with 11 grams of nitric acid and copper (ordinary nitric acid—1.34 Sp. Gr.—with two pieces No. 15 B. and S. gage copper wire three-quarter inch long, and one hour later two more pieces), and cooling by setting the glass into a basin of water 50 deg. to 60 deg. Fahrenheit. Brownish spots form in the course of two hours, or in case of a bad oil masses form around the edges and gradually cover the whole surface. No. 4 (acidity) can be determined by shaking one-quarter of a test-tubeful of oil with an equal quantity of warm distilled water, let stand and carefully pour off the oil. Test the water with blue litmus paper. No more than a faint reddening is allowable. For No. 5 put about 1 inch of oil into each of two test-tubes, add to one of these two pieces of metallic sodium as large as half a pea, and to the other a similar quantity of caustic soda. Heat the tubes immersed in an oil bath to 445 deg. for light colored oils and 480 deg. for dark colored oils. If animal or vegetable fats are present, they will saponify and rise to the top and solidify to a soapy jelly of greater or less consistency, according to the amount of fatty oil present.

Desirable characteristics for ordinary marine practice are as follows:

Kind of Oil	Gravity Deg. B.	Flash Point Deg. F.
Engine	27-30	410
Gas engine, cylinder..........	26	509
Cylinder	23-25	525
"	26-28	400-575
Turbine	25-27	355

(See Engine Room Chemistry, A. H. Gill.)

Use the most fluid oil that will stay in place and do the work. The best oil is that which possesses the greatest adhesion to metal surfaces and least cohesion among its own particles, as mineral oils, sperm, and neatsfoot oils, in the order named.

Q.—How much of a reduction in speed will be caused by foulness of bottom? For example, the ship I am on is an American coastwise steamer, running between New York and Southern ports, and is usually docked every six months. We always think there is an appreciable gain in speed after being docked. Is this so? S. S. D.

A.—There is undoubtedly a gain in speed after cleaning a foul bottom. As for the quantitative effect of foulness of bottom there are few data available, for there is no way of standardizing the *amount of foulness*. Moreover, ship bottoms foul at very different rates on different routes, so that *time out from dock* cannot be used as a gage of foulness. Surfaces covered with a fine or medium sand have more than double the frictional resistance of varnished surfaces, and it is probable that if a ship's bottom is very badly covered with barnacles and marine growths, as occasionally happens after long voyages in tropical waters, the frictional resistance will be increased to four or five times that of the clean bottom. This, of course, does not happen in cases like yours, and it would probably be fair to estimate that the increased resistance was about 20 to 30 percent of the clean bottom frictional resistance at the end of the six-months' period. This would correspond to about 10 to 15 percent increase in the *total* resistance or in the power to maintain the speed of the ship with a clean bottom. Measurement of the increased resistance by noting the reduction in speed is an insensitive method, as the power varies about as the cube of the speed. In other words, an increase in resistance of 15 percent would, with the same power at the engines, result in a reduction in speed of but 5 percent, or about one-half knot for a ship whose speed in the clean condition was thirteen knots. If the ship has to maintain a given speed, it will require an increase in power, and therefore coal, of the full 15 percent. It is obvious that the economical interval for a company to operate its ship without docking is one such that the increased coal consumption equals the docking costs.

Q.—What is the maximum economical time for a ship to operate without dry-docking and cleaning? J. P. Whiting.

A.—See foregoing question.

Q.—How are the revolutions of a turbine determined in the design for a marine installation, and how can I estimate approximately the size of rotor for a Curtis turbine, if I know the power needed? C. P. R.

A.—In general the efficiency of a propeller is higher for slow revolutions per minute and the efficiency of a turbine is higher for large revolutions per minute. The desirable peripheral velocity of a turbine is a function of the steam velocity at exit from the nozzles, and therefore the minimum revolutions per minute is governed by the maximum diameter rotor which will go into the space intended for the turbine, as $V_{\text{periph.}} = \frac{\pi \times D \times RPM}{60}$. If the steam chest pressure were 250 pounds and the turbine of the Curtis type, the drop to the first stage is usually about one-half, so that, assuming this, there would be about 57 British thermal units available for producing velocity. The velocity V_1 at exit from the nozzles would be approximately $V_1 = 223 \sqrt{57} = 1{,}685$ feet per second. From the table of coefficients given in a previous question it is apparent that the peripheral velocity V should be about 10 percent of V_1 for a 4-wheel unit, such as is customary for the first stage; therefore $V = 168.5$ feet per second, and if we can have a diameter of casing of 11 feet with about 10 feet for the diameter of the rotor, the revolutions per minute would be $168.5 = \frac{\pi \times 10 \times RPM}{60}$, revolutions per minute = 332.

The problem may be approached from the other side by accepting the revolutions per minute for the propeller as high as can be used without undue departure from good efficiency and then making the rotor as small as this permits.

Q.—One of my engineers has been talking to me of a preparation in which he is interested which is intended to harden copper. It is supposed to be handed down from prehistoric times, or to be derived from analysis of the old hard bronze implements. Is there anything in it? Q.

A.—Probably not. The description has the earmarks of a common catch-penny scheme, especially the mysterious powder and the "hard as steel" part. There are several commercial bronzes on the market now, the major element of which is copper and which can truly be called as hard as steel. Tobin bronze (about 60 percent), for instance, is rolled every day to give ultimate tensile strength 66,000 pounds per square inch, ultimate compression strength 180,000 pounds per square inch, elongation 25 percent, and good wrought steel has 58,000, 150,000 and 25 percent for the same functions.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries — Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

The Use of Silver Nitrate

The use of silver nitrate as a testing agent for determining the pressence or the absence of salt in water on board ship is quite common throughout the world. It is only proper that this should be the case, for this is the simplest and best purely qualitative test for certain purposes (notably for testing supposedly fresh water from the distilling apparatus) that has been devised. This is not a quantitative test to any marked degree, but by means of it, it is possible to get a general idea as to whether there is a great deal or only a small amount of salt in the water under test. It is my purpose to give a little general information regarding this material, both from a chemical standpoint and from experience on board ship.

Silver nitrate ($AgNO_3$) is obtained on the market as a nearly white crystalline substance. It is very expensive (costing at least fifty cents (2/1) per ounce under the best of conditions), and therefore should be treated with great care and with a view toward economy. When prepared for use on board ship these crystals must be dissolved in distilled water so as to form a colorless solution. The silver nitrate will dissolve in its own weight of water, but such a solution would be needlessly strong and much too expensive for frequent use. A solution of from 2 to 3 percent silver nitrate (by weight) should be amply strong for any use on board ship. With such a solution only one drop should be necessary to give a satisfactory test. From experience, I have found it practically impossible to persuade men to use such a small quantity as a drop, so as to prevent needless waste of valuable material, I always make the solution much weaker, say 1 percent of $AgNO_3$. If the man making the test pours in several drops of this weaker solution there will have been expended only the same amount of silver nitrate that would have been used if one or two drops of the more concentrated solution had been dropped in.

The general tendency of the men who usually make this test is to believe that quantity plays a large part in the reaction obtained. On this account I have repeatedly seen a man pour in about a teaspoonful of nitrate solution and. failing to get a reaction, but being somewhat suspicious, then pour in about as much a second time. If one drop of the silver nitrate solution is dropped into the water it should give a sharp local reaction if much salt is present, and should show a white, cloudy appearance for even a trace of salt. A general realization of this fact would save a good deal of valuable material.

In preparing a silver nitrate solution aboard ship, great care should always be taken to prevent the loss of the whole lot of crystals to be used. In several cases I have seen this happen on account of careless work in preparing the solution. Since water on board ship always stands a good chance of being contaminated with salt, only two or three small crystals of silver nitrate and a small amount of water should be taken at first. If, after the crystals are dissolved, the solution is perfectly clear, the water may be considered of sufficient purity to be used for dissolving the whole lot. The testing solution may then be prepared with this water. On the other hand, if the first small solution shows cloudiness on account of a fine white precipitate, the water used is not of sufficient purity to use for the whole solution, and a better water must be obtained. Water for preparing the testing solution must not be used unless it fails entirely to give a reaction when tested with another solution or when tested with a few crystals, as described above.

The principal impurity of sea water is common salt (sodium chloride, $NaCl$), of which it contains approximately 2.75 percent. It is this salt that is immediately shown up by the silver nitrate, even when it is present in very small quantities. When the testing solution is added the following reaction takes place if any salt is present in the water:

$$\underset{\text{Silver nitrate.}}{AgNO_3} + \underset{\text{Sodium chloride.}}{NaCl} = \underset{\text{Silver chloride.}}{AgCl} + \underset{\text{Sodium nitrate.}}{NaNO_3}$$

The silver chloride comes down as a white precipitate, practically insoluble in water; the sodium nitrate remains in solution in the water. As a matter of information it might be well to add that the white precipitate is quite insoluble in any ordinary acid solution, but is very soluble if the solution should be made at all ammoniacal.

The usual custom seems to be to keep the silver nitrate solution in a clear, glass bottle, but this should not be the case. The testing solution should always be kept in a dark bottle (brown, black, etc.) so as to exclude the light, because silver salts are readily darkened by too much light. This is the reason that the precipitate obtained on test ($AgCl$) will readily darken if left exposed to the light for any length of time.

Silver nitrate solution should always be added with a medicine dropper, both to save time and material. Care should be taken to keep it from getting on the hands, as it will cause black spots wherever it is allowed to remain very long. These spots are removed from the skin with considerable difficulty.

If the silver nitrate test is used properly and carefully it will be found to be a very satisfactory test for certain purposes. Of course, this test could never be satisfactory for testing boiler water, as it will always give a reaction with such water. What is wanted in such a case is a quantitative test, not a qualitative one. The silver nitrate test is principally one for determining whether or not the water under test is free from salt—not how much salt it contains.

W. W. B.

Propeller Blade Layout

In the following article the writer assumes that the reader has had some experience in laying out propellers; therefore only references will be made to the various authorities from which the formulæ, data, etc., are taken; it being further assumed that any one sufficiently interested in the subject would prefer to consult the given authorities. The propeller in the illustration has been taken from a turbine-driven torpedo-boat destroyer not using reduction gearing. The small diameter of the propeller is necessitated by the high number of revolutions at which the propeller turns, and this, with the large area

being confined to the small diameter, is the cause of the extreme fullness of the blade.

In laying out propeller blades in the drafting room the necessary data and information required for the draftsman to proceed with the delineation are obtained by calculations made either by the draftsman or by the computing division. A treatise by Captain C. W. Dyson, U. S. N., on "Screw Propellers," Volume I, Text, and Volume II, Atlas, will be used in making the necessary calculations and for obtaining the shape of blade.

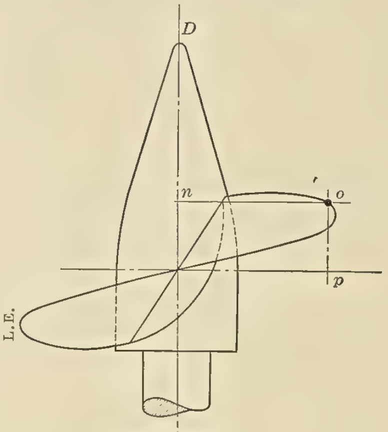
The necessary data obtained from the calculations are the pitch, diameter of screw, number of blades, and the projected area. The projected area will be used as the basis in starting the layout of blade; the shape or form of contour of the projected blade area is taken from Captain Dyson's Chart No. 8, Sheet 24, Volume II, Atlas, from which the corresponding blade of $\frac{PA}{DA}$ ratio is taken.

PA = projected area and DA = developed area.

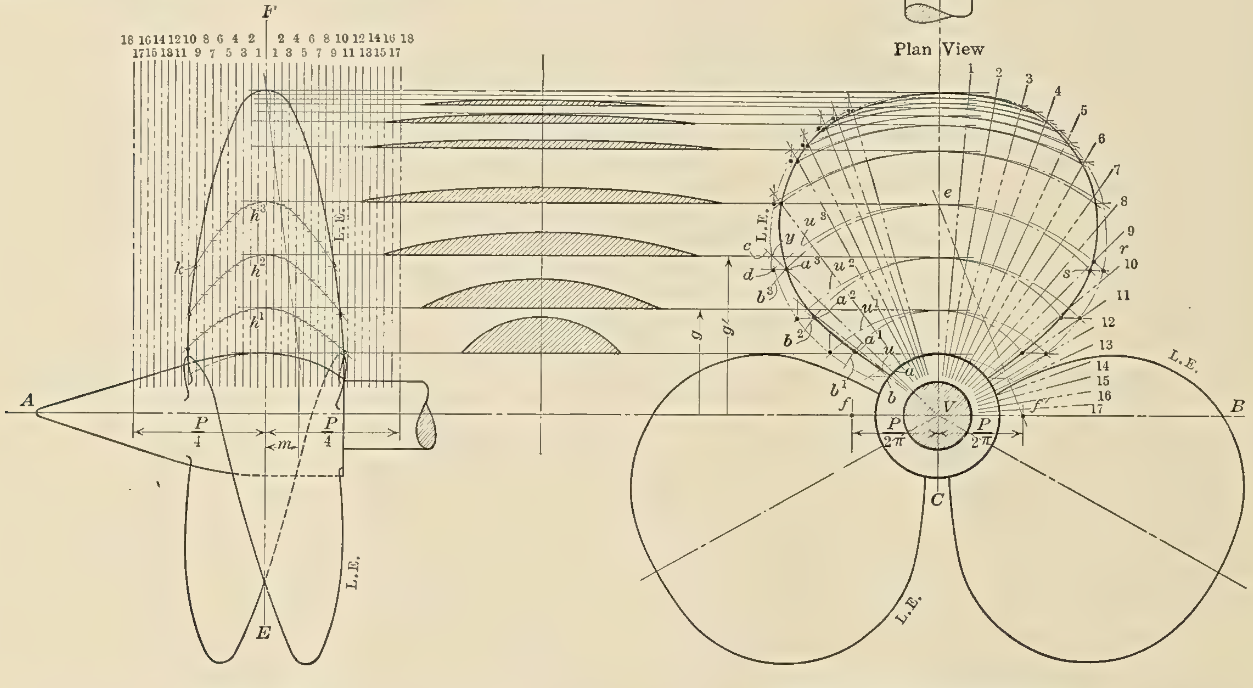
In transferring this shape of blade to your layout, the chords of the half-arcs may be scaled off with a scale proportional to the radius of blade, and then layed down

tip is subdivided as often as is necessary in order to obtain as many points in the flat contour of the blade at the tip as is desired for the correct contour of the developed blade.

In proceeding to draw in the contour of the helicoidal or developed area, locate the two foci f and f^1, whose distance from the center of hub, on the horizontal axis, is $\frac{P}{2\pi}$; the derivation of the term $\frac{P}{2\pi}$ can be found in



Plan View



Athwart View

Fore & Aft View, Looking Aft.

Right-Hand Screw: Diameter, 6 Feet 3/4 Inch; Pitch, 5 Feet 1/2 Inch; P. A., 18.52 Square Feet; Ratio P A to D A, 0.64

to the new proportions on the fore-and-aft view of the blade desired. These arcs, on which the half-chords are measured, are at tenth units of the radius on Chart No. 8. Of course, you could choose any unit of radius, in measuring the half-chords in transferring the shape of blade, or the shape could be transferred by another method, viz., draw radial lines from the center of the hub, as V-1, V-2, etc., in the illustration, and then scale the distance from V to the contour of the blade with a scale proportional to the radius of blade desired.

After having the contour of the projected area of the blade drawn in, as shown on the drawing in the fore-and-aft view in heavy line, take a planimeter and check the projected area to see whether there is any appreciable error. Now draw in the different circular arcs, as b^1, b^2, b^3, etc., taken at even dimensions from the hub out to the tip, with radii g, g^1, etc. The outermost division at the

most books of authorities on screw propellers. Points a^1, a^2, a^3, in the contour of the projected blade are to be found in the developed contour. For example, take point a^3 and draw a line from the center of the hub through point a^3 as line V-c. Now take the distance from focal point f^1 to the intersection of the vertical axis C-D, with the circular arc b^3; with f^1-e as a radius, and V as a center, cut the line V-c with an arc. Draw a vertical line through the intersection and produce a horizontal line from a^3 to the left d, the intersection of the two lines just drawn is a point in the developed contour.

The circular arcs b^1, b^2, b^3, etc., are parts of the minor axis circles of the different ellipses taken at different distances out on the blade. Points a^1, a^2, a^3, etc., in the projected contour, are always found on the minor axis circles. Points in the developed contour, as d, etc., are always found on the ellipses. f and f^1 are foci for all the

different ellipses, therefore distance f^1-e is the radius of the major axis circle of the ellipse a^3. The ellipses u, u^1, u^2, etc., can be drawn by any approximately correct short method having major and minor axes given. It is considered sufficiently accurate, as they are used only in stepping off the width of the sections of the blade. After having established enough points to form the contour of the developed blade, draw a smooth line through them. This completes the fore-and-aft view of the blade, the remaining two blades of the propeller can be drawn in by any correct method of transfer from the blade just drawn.

In order to draw the contour of the projected area in the athwart view of the propeller, we take in the fore-and-aft view the right angle *DVB*, which is one-fourth of the disk, or one-fourth of the pitch or generating helix, and divide it by radial lines into 18 equal parts of 5 degrees each, namely, 1, 2, 3, etc.

In the athwart view we take a distance on each side of the vertical axis *F-E*, equal to $\frac{P}{4}$, and divide this distance into 18 equal parts, the same number that we have in the fore-and-aft view between *D-B*, because one-half of this view of the blade takes one-fourth part of the generating helix, which is the distance $\frac{P}{4}$. Now draw the parallel vertical lines to the right and left of the axis *F-E*, as 1, 2, 3, 4, etc., respectively, projecting the points of intersection of the projected contour, with the circular arcs. For example, take the circular arc b^3 at the intersection with the projected contour at point *s*. This point is located about one-quarter of the distance between radial lines marked 9 and 10. Projecting this point *s* horizontally across to the athwart view, placing it one-quarter of the distance between vertical lines 9 and 10, point *k* will be a point in the contour of the blade in the athwart view. After establishing enough points to form one-half of the contour of the blade, draw a fair curve through them and complete the other half of the blade by transfer. Point *s*, it will be noticed, is located on the contour of the following half of the blade, when projected to the athwart view, *k* will be likewise located in the contour of the following half of blade, which is on the left of center line *E-F*. The two remaining blades can be drawn in by the same method; but care must be taken, to be sure, that the proper edge of the blade is projected in relation to its location. In the drawing the leading edge is marked *L-E*.

By projecting the points of intersection of the circular arcs b^1, b^2, b^3, etc., in the fore-and-aft view, with radial lines 1, 2, 3, 4, etc., over onto corresponding 1, 2, 3, 4, etc., vertical parallel lines in the athwart view; and after drawing a fair curve through these points of intersection we will have produced the different helical curves, as h^1, h^2, h^3, etc., at the different distances out on the blade, as g, g^1, etc. However, these helical curves have no practical value in making the propeller; they are, therefore, omitted on all modern drawings of propellers.

The plan view of the blade is invariably omitted on modern drawings, as it in no way aids the pattern-maker or the foundryman in the making of the propeller, but just for drawing purposes, the method for obtaining points in the contour of the blade will be given. Any point in the projected contour in the fore-and-aft view can be taken. For example, we will take *r*. Take the horizontal distance from *r* to the vertical axis *D-C* and lay it down on the plan views as *n-o*. Point *r* falls on the radial line 9, so in the athwart view take the distance from the vertical axis *F-E* to the vertical line 9, and lay it down in the plan view as *p-o*. The intersection of *p-o* and *n-o* at *o* is a point in the contour of the blade in the plan view.

In calculating the thickness of the blade the formulæ used are taken from D. W. Taylor's book on "Resistance of Ships." In the athwart view dimension *m*, thickness of blade at the hub, is, in most cases, the only thickness to be calculated, the blade being considered to be a beam fixed at one end only, and uniformly loaded. The back edge is a parabolic curve; but in most cases a straight line from the hub thickness *m* to the vertical axis at tip, as shown, allows sufficient metal. Just enough metal is added at the tip to take care of corrosion and curling over of the edge.

The dimensions of the hubs of propellers are based on the diameter of the shaft, and previous hubs are always referred to in determining the design, with a point in view of standardizing as much as possible to take care of any isolated cases of interchangeability, but primarily to have a standard design for different classes of vessels.

The sections of the blade shown between the fore-and-aft and athwart views are easily drawn. The length of the sections at the different diameters out on the blade are obtained by stepping off the length on the elliptical curve corresponding to the respective diameter at which it is taken and layed down on a horizontal base line. Lay off the thickness at the center of the blade from the athwart view, which shows the different thicknesses of blade from the root on out in dot and dash lines. Then draw in the shape of the back of the blade with any convenient radius which will allow sufficient metal at the edge. The edge is filled in with a very small radius.

Washington, D. C. Harold M. Adams,
Draftsman, Bureau of Steam Engineering, Navy Department.

Refloating the Steamship Zeeland by Compressed Air

Scientific methods are rapidly revolutionizing salvage practices. Mere horsepower and the tensile strength of hawsers are no longer the determining factors in getting a stranded ship afloat. True, tugging energy and lines are still valuable adjuncts, but other facilities are playing a big part in winning success. Possibly there is no more striking example of this new era in salvage work than that recently offered in the refloating of the steamship *Zeeland* of the International Navigation Company.

Early last November, this vessel of nearly 12,000 tons, was bound up the St. Lawrence from England to receive an important cargo for a speedy return voyage. During thick weather the *Zeeland* got out of the channel and went ashore at a point between Montreal and Quebec while running at pretty good speed. In fact, she hit the mud so hard that she landed about 36 inches above her light load line and had very little cargo in her which could be removed to lighten her. It was of the utmost importance that the vessel be refloated with all possible speed, and the underwriters believed the quickest solution would be that of dredging a channel for the ship back to the regular course of traffic. This was done, including the removal of the mud from both sides of the ship. This, however, left the *Zeeland* still resting upon a bank immediately beneath her which could not be reached by the dredges. It was found impossible to break the suction between the craft's bottom and the mud by direct pull and the working of her own engine did not help matters. The *Zeeland* was held held hard and fast.

At this point the salvors proposed to cut the rivets of some of the bottom plates from within the ship and to drop

these after compressed air had been used to charge the overlying ballast tanks and neighboring compartments, the idea being that the escaping excess air working its way upward through the openings so made would break the hydrostatic seal and free the craft. Theoretically the proposal was all right, but the practical drawback lay in the fact that the *Zeeland* would have to be docked on reaching Montreal for the purpose of replacing the detached plates. Only a few days remained before the St. Lawrence would close by reason of ice, and there was the risk of the ship being caught and prevented from making the urgently desired run to England.

The well-known salvage expert Mr. W. W. Wotherspoon was present on the *Zeeland* representing the concern that had rented an air compressor and some other fittings to the contract salvors. He was asked for advice and the refloating of the ship was sublet to him on a basis of no pay if unsuccessful, and just three days were given him in which to solve a problem which had staggered the people already on the job. Mr. Wotherspoon was opposed to the detaching of some of the bottom plates and the application of compressed air in the manner already suggested. He was quite willing to use compressed air but he determined upon a more ingenious and less hampering application of it.

Like most large steel vessels, the *Zeeland* had a double row of composition drainage plugs screwed into the plating of her bottom. These were intended to be removed from outside, whenever the ship were docked and this manner of draining the bilge, etc., was deemed desirable. Mr. Wotherspoon decided to remove fourteen of these at seven different positions along the vessel's bottom, and to this end he had his men tap a couple of holes in the inboard ends of these screw plugs. It was a simple matter then to work them out-board by means of key wrenches. With this done, the threaded ends of flexible pipe connections were screwed into the holes and the attached rubber hose led to the salvage air compressor.

Prior to this, a wire hawser passing around the ship's stem had its two ends secured to the winches aboard the two dredges, one on each side of the *Zeeland*, which were anchored in addition to having their spuds lowered deep in the mud. Ten big sea-going tugs, pulling in tandem, were connected by five lines to the stern of the steamship. With the water removed from her ballast tanks, and everything in readiness, then the air jets were started, while the *Zeeland's* engines of more than 12,000 horsepower joined in the efforts of the tugs and the powerful winches of the dredges. Inside of ten minutes from the turning on of the air, the hydrostatic seal was broken and the liner hauled out into the regular channel, and a few moments later was bound for Montreal under her own steam.

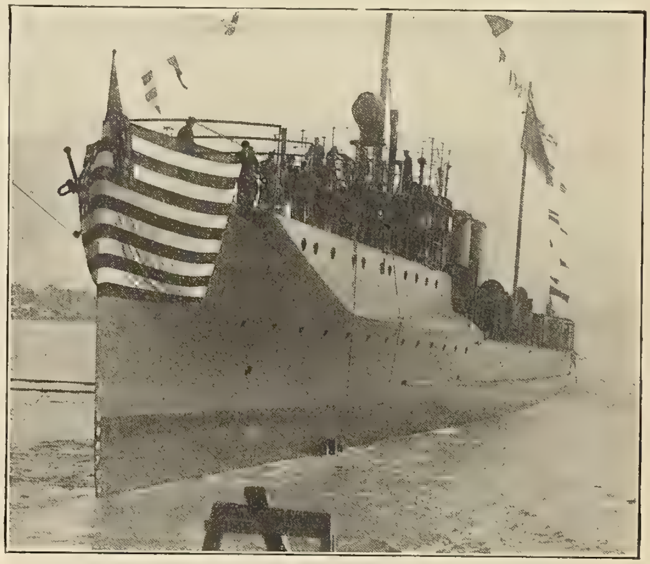
With the ship thus released, Mr. Wotherspoon had his men break the pipe connections, and in place of the original drainage plugs screw bolts were substituted from inside the ship, which effectually sealed the holes. This was a matter of but a few minutes' work, and there was no necessity for the *Zeeland* going into drydock before loading for England. As it turned out, she took on her cargo and cleared from the St. Lawrence some days before ice put a stop to further traffic. Mr. Wotherspoon gives credit to the United States Army Engineers for the inspiration which made this performance possible. It seems that water instead of compressed air was similarly employed in breaking the seal between the mud and the bottom of the vessel when the wreck of the old battleship *Maine* was refloated from the bed of the Havana Harbor. In this case, however, he chose compressed air because he could more certainly count upon its forceful upward trend to break the grip of the suction. R. G. SKERRETT.

Launch of the U. S. Destroyer

The United States torpedo boat destroyer *Cushing* was launched January 16 at the yards of the Fore River Shipbuilding Corporation, Quincy, Mass., and christened by Miss Marie L. Cushing, of Fredonia, New York, the daughter of Lieutenant-Commander Cushing, in whose honor the vessel has been named.

The *Cushing* is one of a class of six destroyers authorized by Congress in 1912. She is 305 feet 3 inches long, 31 feet beam, 18 feet 3 inches depth, and has a displacement of 1,050 tons on a mean draft of 9 feet 5½ inches. She is of the usual torpedo boat destroyer design with a high forecastle, the model for which has been practically standardized by the Navy Department for this type of vessel.

The hull is built entirely of steel, and is divided by watertight and oiltight bulkheads into fourteen principal watertight compartments. All of the strength members of the hull are of a special high tensile steel, which increases the strength of the vessel by about 33 percent.



Destroyer *Cushing* Launched; 85 Percent Complete

Her fuel oil tanks have a capacity of about 93,000 gallons of fuel oil.

The armament of the *Cushing* consists of four 4-inch rapid fire guns and four twin torpedo tubes. In view of the strenuous life experienced during maneuvers and in warfare by the officers and crew of vessels of this type, special attention has been paid to the living spaces, and very comfortable quarters are provided for 6 officers, 8 petty officers and 86 men.

The propelling machinery consists of two sets of Curtis turbines in combination with cruising turbines and reduction gears capable of driving the vessel at a speed of 29 knots. Steam is supplied at a working pressure of 265 pounds per square inch by four oil-fired watertube boilers of the Yarrow-Fore River type placed in two watertight compartments.

OBITUARY.—Charles Ward, founder of the Charles Ward Engineering Works, Charleston, W. Va., died from pneumonia on Jauary 17. Mr. Ward took an active part in his general business until a few days before he died, as he was at the works on January 7 and 8 during the launching of the steamer *Inspector*. Mr. Ward has long been prominent in the marine affairs of this country, having specialized in the building of shallow draft river boats and safety watertube boilers.

Marine Articles in the Engineering Press

Geared Turbines for Ship Propulsion—Description of the Largest Ship Fitted with Geared Turbines—Improving Boiler Efficiency

Sixteenth Principal Meeting of the Ship Technical Society.—The article states that, owing to the war, one day was set for the meeting and only three papers were read. The first of these dealt with "Fish Steamers and Deep Sea Fishing," describing the types of deep-sea fishing steamers, the methods of operation with the necessary implements and the equipment of the vessels. Statistics were added, not only of German-built fish steamers, but also of English, French and Scandinavian fishing vessels. The discussion of this first paper is stated to have brought out a good many interesting points upon trim, stability, seaworthiness and motive power of fishing steamers. The second paper, on "Oscillations of Ships and Their Influence on Stability," dealt with the uncertainty of calculation of the period and curves of oscillation, as compared with actually observed cases. The discussion pointed out the desirability of model experiments. The third and last paper, on "Efforts Toward Simplification of Steam-engine Construction," is stated to have been a description of an engine of interchangeable parts. 2,680 words.—*Schiffbau,* December 9.

The New American Battleships.—By Morris Prendergast. The main particulars are given of the American battleships of the *Nevada, Pennsylvania* and *California* classes. The whole seven ships in these three classes, although differing in size and other details, are designed to form a tactically homogeneous group. They possess the same speed, turning circles and arcs of fire for the main guns, so that they may act in unison. In appearance they are very similar, each ship having one funnel and two of the typical American lattice-work masts. In the *California* class, an overhanging bow of the Japanese type has been introduced for increased seaworthiness. The principal improvements in the *California* class are extended internal protection, slight increase in armor thickness and the extension of the forecastle deck level to form a higher central position for the 5-inch guns. Little reference is made to the engineering features of these vessels, except to note the introduction of electrical propulsion on the *California.* The main points considered are the armor and armament of the ships. 1 illustration. 2,400 words.—*The Shipbuilder,* December.

The New Cunard Geared Turbine Liner Transylvania.—A fully illustrated detailed description of the twin screw geared turbine passenger and cargo steamer *Transylvania,* recently built by the Scotts Shipbuilding & Engineering Company, Ltd., Greenock, for the Cunard Line. The vessel is 567 feet long overall, 66 feet 3 inches molded breadth and 45 feet molded depth to shelter deck. The gross tonnage is 14,315 and the displacement at a draft of 27 feet 6 inches, 19,400 tons. The total deadweight capacity at the above draft is 8,700 tons and the speed on service 15 knots. Accommodations are provided for 305 first class, 216 second class and 1,858 third class passengers. The vessel is classed 100 A-1 Lloyd's shelter deck. In all there are eight decks, five of which extend over the full length of the ship. The hull is subdivided into fourteen main transverse watertight compartments by thirteen watertight bulkheads. Special reference is made to the construction details and riveting. The passenger accommodation is all situated above the lower deck, the spaces beneath that deck being devoted to cargo and to ship's stores, machinery and coal bunkers. The main turbines and propellers were designed for 1,500 and 120 revolutions per minute, respectively, the ratio of reduction of the gearing being 12½ to 1. There is a high and low-pressure ahead Parsons turbine of the reaction type for each propeller shaft. The maximum power without the use of the bypass valves is 9,500 shaft horsepower and the steam consumption of the turbines is 11½ pounds per shaft horsepower per hour. At full speed on trial the turbines ran at 1,630 revolutions per minute and the propellers at 130 revolutions per minute. Steam is supplied at 210 pounds pressure by six double-ended Scotch boilers, 16 feet in diameter and 12 feet long, working under natural draft. The boilers are arranged in groups of three in two boiler rooms. 9 illustrations. 2,600 words.—*The Shipbuilder,* January.

Geared Turbines for Ship Propulsion.—By W. D. McLaren and G. M. Welsh. Outline particulars of the machinery for a number of typical vessels are given. In each case particulars and estimated performances for machinery of the ordinary type have been first prepared, and similar particulars of geared turbines suitable for each vessel have been computed for comparison. In making the comparison between the performance of geared turbines and other types of machinery consideration is given to the thermodynamical and mechanical efficiencies of the prime mover, and to the propeller efficiencies in the respective types. The method which has been adopted to give this means of comparison is as follows: The resistance of each vessel has been estimated and a curve of E. H. P. plotted on a speed basis and then curves of T. H. P., D. H. P., S. H. P. and I. H. P. have been built up. The consumption of steam has been estimated in each case, and also the boiler evaporative efficiencies for the conditions chosen. From these estimates, values have been found for the coal consumption per 100 miles and all the results have been plotted in diagram form. In all, twelve typical vessels were chosen. It was found in all the cases considered, with the exception of a high-speed liner fitted with high-pressure, intermediate-pressure and low-pressure turbines direct coupled to propeller shafts supplied with steam from cylindrical boilers with forced draft, that the geared turbines show at full power an advantage of coal consumption over the reciprocating or direct-driven type of machinery. The amount of gain in ecenomy depends on the type of ship considered and the curves indicate how this gain is influenced by reduction from the full power condition of running. Attention is drawn to the fact that in comparison with reciprocating engines the reduction in coal consumption becomes unappreciable at low powers and that at some speeds considered the reciprocating engine proved the more economical. Attention is also directed to the manner in which the gain is influenced by propeller efficiency as apart from the thermodynamical efficiency of the prime movers. From the point of view of commercial efficiency, the questions of cost and space occupied by the plant must be taken into account. While the former consideration is outside the scope of this paper, nevertheless, in respect to the latter, some idea can be formed of the saving in boiler room space that may be effected in most cases by the installation of geared turbines. 23 illustrations. 6,500 words.—*Transactions of the Institutions of Engineers and Shipbuilders in Scotland,* November.

How the Efficiency of the Scotch Boiler can be Improved.—By John Tait. As the weak point in the Scotch boiler is commonly agreed to be its defective circulation,

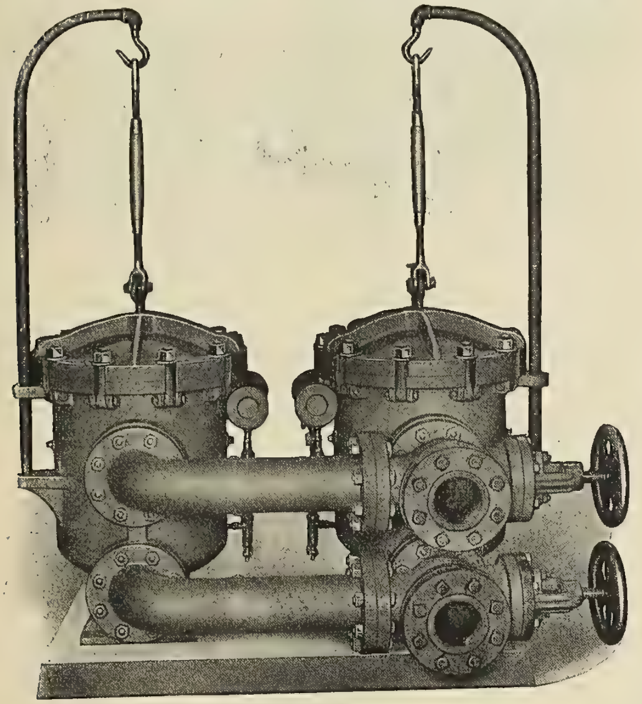
the author came to the conclusion that the trouble could be overcome in a very simple manner by converting a small portion of the hottest part of the furnace into what is practically a saddle boiler, which would draw its supply from the bottom of the boiler. Working models of this arrangement were made and tested, and seemed to give excellent results. Some objections, however, were raised, one being that it would pocket steam with disastrous consequences to the furnace, and another that it would bring up mud and deposit it on the crown of the furnace. These objections, however, did not seem to be sustained in practice. Another point was brought out, namely, that it is a fallacy to suppose that the circulation in the Scotch boiler is good above the line of fire, and could not be greatly improved. There are two distinct phases in the circulation of water in the boiler. First, that due to the varying density of the water as it is being heated. These currents, which are very feeble at low temperatures, grow stronger as the boiling point is reached, but even at their best are poor compared with what takes place when the second stage is reached and ebullition commences. It is, therefore, to the circulation caused by ebullition that one must look for the rapid motion of water over the heating surfaces so necessary for efficiency. As a matter of fact, the lower surfaces in the Scotch boiler are simply feed heaters, and therefore poorly circulated, which accounts for it not having a greater efficiency. While improved circulation at the top of the boiler does not necessarily improve the circulation at the bottom, it is equally true that the ebullition which takes place at the bottom improves the circulation generally. In other words, the lower heating surfaces are, from a circulating point of view, the most important. The ideal condition of a steam generator is reached when there is a rapid flow of water over all its heating surfaces. The next step in improving the efficiency of the boiler is the manner of introducing the feed water so that the action of the circulator and the natural circulation of the boiler are interfered with as little as possible. The feed water difficulty is overcome by having an internal feed pipe, one end of which goes down to the bottom of the boiler, or any place which may be desired, the other end finishing with a bend near the surface of the water and horizontal to it. Into this pipe the feed is led at any convenient point and is directed through a nozzle in such a manner as to draw a continuous stream from the bottom of the boiler. This water, mixing with the colder feed water, brings it so nearly to the temperature of the boiler that the tendency for the feed water to sink is almost eliminated. The combined flow issuing from the mouth of the pipe at a considerable velocity is further mixed with the hot water in the boiler and absorbs sufficient steam in crossing the boiler to bring it up to almost the steaming temperature. The author claims that by increasing the circulation in the bottom of the boiler and supplying the feed in such a manner that it does not come into contact with the heating surfaces, the maximum of circulation is not only obtained over the furnaces, but this in turn improves the whole circulation of the boiler, the efficiency of the boiler is increased and the cost of repairs greatly reduced. 3 illustrations. 3,600 words.—*Transactions of the Institution of Engineers and Shipbuilders in Scotland,* November.

The Twin Screw Passenger and Cargo Steamers Missanabie and Metagama.—The sister ships *Missanabie* and *Metagama* are the largest vessels so far constructed by Messrs. Barclay, Curle & Company at Whiteinch. They were built for the Canadian Pacific Railway Company for service between Liverpool and Canada. They are 520 feet long overall, 64 feet molded breadth, 41 feet molded depth to shelter deck and have a displacement of about 18,000 tons, a gross tonnage of 12,469 tons and a net tonnage of 7,727 tons each. The cargo capacity is about 400,000 cubic feet and the speed on service 16 knots. Accommodations are provided for 520 cabin passengers, 1,200 third class passengers and a crew of 300. The hull is subdivided by seven steel decks, five of which extend over the full length of the ship, and ten transverse bulkheads, three of which extend to the lower promenade deck, four to the shelter deck, one to the upper deck and two to the main deck. This subdivision provides that any three compartments can be open to the sea and flotability still insured. The vessels are classed 100 A-1 Lloyds. All available space below the main deck, outside of the engine and boiler rooms and coal bunkers, is devoted to the carriage of cargo with the exception of the space required for the ship's provisions and stores. Three of the lower 'tween decks are fitted for the carriage of refrigerated merchandise and have been effectively insulated. The entire space on the main deck and upward is devoted to passenger accommodation. Heating and ventilation is on the dual system, which represents an entirely new departure, and consists of two distinct methods whereby every space on board is assured a sufficiency of heat and fresh air. The cargo handling appliances are very complete, three derricks and two powerful winches being fitted to each hatch, while in addition there is a lattice-girder heavy derrick capable of dealing with 25-ton lifts. An efficient fire-indicating extinguishing apparatus is fitted. The life-saving equipment consists of thirty-two boats, one of which is a motor boat. The majority of boats are stowed in nests of two or three on the boat deck. In most cases the Welin "Planet" system of slewing gear is provided to each set of davits, while at one station where the boats are housed right across the deck the davit gear is of the Babcock & Wilcox type. The electric plant consists of three 100-volt Siemens dynamos running at 1,050 revolutions per minute, coupled to De Laval turbines run at 15,000 revolutions per minute. Each set is capable of giving 100 kilowatts continuously and any two can supply sufficient power for all of the lights and motors in the vessel. Electricity is used exclusively for driving engine room auxiliaries, ventilation fans, motors, galley machinery, etc. In the stokeholds, four Howden forced draft fans are each driven by a 21 brake horsepower motor. For the ventilation system there are eight thermotank motors, each of about 4 brake horsepower, and also ten cased fans of various sizes for the ventilation of the galleys and passenger accommodations. In the crow's nest a Siemens 24-inch searchlight projector is fitted. An emergency generator set is placed on the boat deck, which was supplied by Messrs. John I. Thornycroft & Co., Ltd. The motor is of the Thornycroft six-cylinder type, using kerosene (paraffin) fuel, and is capable of developing up to a maximum of 66 brake horsepower. The generator is of 40 kilowatts capacity. Propulsion is by twin screws driven by quadruple expansion engines with cylinders 26, 37½, 53½ and 77 inches diameter with a stroke of 51 inches. Steam is supplied by eight Scotch boilers, 15 feet 9 inches diameter by 11 feet 9 inches long. The boilers work under Howden's hot air system of forced draft and have been constructed for a steam pressure of 2115 pounds per square inch. A detailed description is given of both main and auxiliary machinery. While the engines were designed for a speed of 16 knots on service, on the trial trip the *Missanabie* developed a speed of 17½ knots. 25 illustrations. 5 plates. 4,825 words.—*The Shipbuilder,* December, 1914, and January, 1915.

ENGINEERING SPECIALTIES

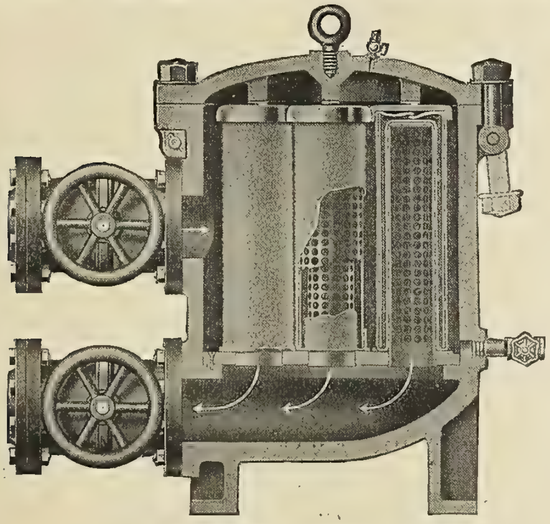
The Blackburn-Smith Twin Filter

The ever increasing number of plants which carry loads varying greatly at different times, or which operate twenty-four hours per day, has necessitated the design of a filter which would have considerable flexibility as to ca-



Twin Filter

pacity, and which would permit of the cleaning of one part while the other is in operation. It is readily seen that if a filter of this type is selected of such size that either side alone can carry the regular load, then the two sides can be thrown in during the peak load, thus permitting the



Section Through Filter

thorough filtration of all the water at all times, and without interference by the necessary cleanings.

In the new type of Blackburn-Smith feed water filter and grease extractor having twin bodies controlled by a single set of inlet and outlet valves, which is now being built by James Beggs & Co., 38 Warren St., New York, N. Y., the turning of both valves to one limit by-passes the corresponding body, and the other body is by-passed by turning both valves to the other limit, thus permitting the alternate operation and cleaning of either side. The combined operation of both sides, as would be desirable during the peak load, is accomplished by turning the valves to mid position.

The filter is made up of a number of parts, so that breakage or disarrangement of any particular section does not necessitate the discontinuance of all filter service, and as these machines are tested to 400 pounds hydrostatic test pressure before shipment, the probability of such interruption of service from defective material or workmanship is unlikely. The valves are of the double seat type and the disk working between the seats is self-seating, thus preventing leakage due to dirt deposited on either disk or seat.

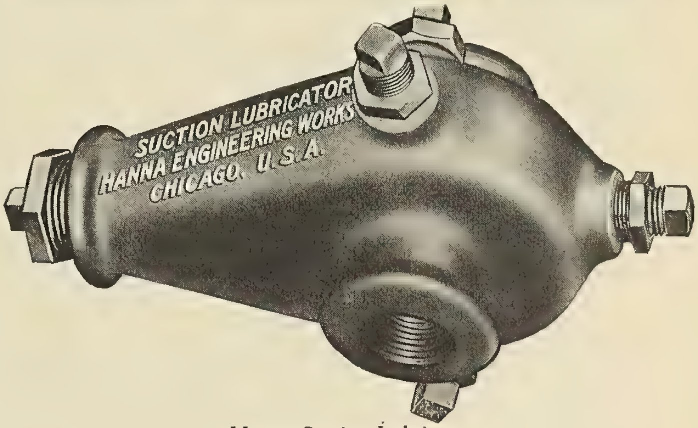
The filter chests are the same as in the single type of Blackburn-Smith filter—each divided into an inlet and an outlet chamber by a partition carrying the filtering cartridges. Each cartridge consists of two concentric perforated brass cylinders so covered with linen terry cloth that two uniform separated and successive filtering surfaces are put into the path of all entering water. The opening of the filter for cleaning is facilitated by the use of a large cover held by swing bolts. A crane and turnbuckle lift swings and holds the cover during cleaning with a minimum of labor.

A Suction Lubricator

A new and novel lubricator, made in three sizes for ¾-inch, 1-inch and 1½-inch pipe connections, for use particularly on devices operated by compressed air, has just been placed on the market by the Vulcan Engineering Sales Company, Chicago, Ill.

The principle involved is one of suction. A chamber containing an absorbent is kept saturated from another large oil storage chamber surrounding it. Air passing through the lubricator becomes sufficiently charged with oil to properly lubricate all surfaces with which it subsequently comes in contact.

This device is entirely automatic, because suction action takes place the instant the air moves and ceases the instant the air is shut off, and the take up of oil is very moderate, though continuous when air is being used. It



Hanna Suction Lubricator

can be attached to the air line in any position and operate in any plane or at any angle, and can be filled no matter what position it is in. It is therefore universal and foolproof.

It is claimed the suction lubricator will prolong the life of pneumatic equipment and greatly conserve the amount of lubricant used, thereby increasing efficiency and reducing maintenance costs.

New Steamship Regulation, Effective January 1, 1915

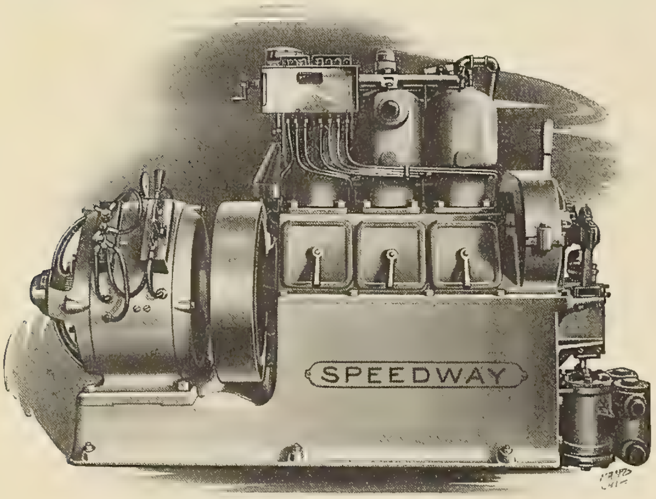
At a recent session of the Board of Supervising Inspectors an important regulation was adopted as Section 16, Rule IX, General Rules and Regulations for Ocean and Coastwise Vessels. This regulation reads as follows:

"On and after January 1, 1915, all steamers carrying passengers subject to the inspection of this service, which are provided with a plant for electric lighting purposes, the dynamos of which plant are located below the deep load line, shall have on board an auxiliary plant located above the deep load line, capable of thoroughly lighting the vessel in case of an emergency."

This regulation also applies to steamers navigating on lakes, bays, sounds and rivers.

In order that gasoline (petrol) generating sets may be used—as this system is entirely independent of other power sources on board ship—section 4472, Revised Statutes, has been amended to permit that product and other products of petroleum to be carried on vessels for gasoline (petrol) lighting and wiring systems.

The Gas Engine & Power Co. and Charles L. Seabury & Co., Consol., of Morris Heights, New York City, produce such auxiliary generating sets in 3-, 4-, 7-, 12- and



Speedway Auxiliary Generating Set

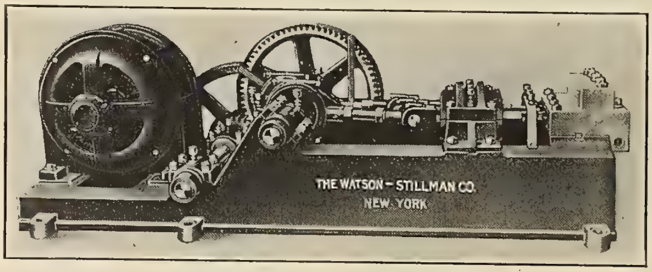
25-kilowatt capacities, operating 54, 125, 220 and 450 16-candlepower lamps respectively, or 100, 240, 425 and 850 8-candlepower lamps respectively. The 12-kilowatt set operates at 600 revolutions per minute by means of a 4-cylinder, 4-cycle gasoline (petrol) engine of 6-inch bore and 6-inch stroke, the total weight of this outfit being about 3,000 pounds. The accompanying illustration shows a 4-kilowatt set with air compressor and small bilge or fire pumps attached.

Watson Stillman Triplex Hydraulic Pump

The Watson-Stillman Company, New York, has added to its line of high-pressure hydraulic pumps a new type of motor-driven geared triplex single acting pump, which embodies some features of special merit. While primarily designed to meet the severe demands of tunnel service, it will be equally appreciated for other conditions.

To secure unusual compactness and rigidity, and also to insure perfect alinement of all the working parts when under severe service, the motor is mounted on an extension of a heavy cast iron base. The driving shaft and bearings are large and are amply provided with lubricating cups. The gears are of the heavy cut tooth type. The drive from the shaft is by eccentrics set at 120 degrees and are cast in one piece and keyed with one key to the driving shaft. The eccentric straps are heavy and the plungers are of tool steel and are guided in a rigid crosshead guide, which is keyed and bolted to the base.

The pump body is a machine steel forging with bronze valves and bonnets, and designed to eliminate and aid



Motor-Driven Hydraulic Pump

spaces. The passageways are made large to reduce friction of the water to a minimum. The pump as shown is operated by a 10 horsepower motor running at 600 revolutions per minute and delivers 100 cubic inches per minute at 3,500 pounds pressure, with a speed of the crankshaft of 100 revolutions per minute. Other sizes are built to suit operating conditions.

Proper Eye Protectors

In a large shop in New York State all the chippers are provided with eye protectors. Only a short time ago one of these workmen was struck in the eye by a very heavy chip of metal, which drove the glass back through the frame of the protection glasses he was wearing. His eye was so seriously injured by this glass that it had to be removed. These glasses offered no protection from the broken glass. The case was settled for over $4,000 (£820).

On the other hand, one of the largest steel works in this country provides the men with safety glasses which have a safety flange extending over the back of the glass. This flange prevents glass going through and injuring the eye. Recently one of their workmen was struck by a swinging crane hook. The terrific force of the blow smashed the glasses and stunned the man, but not an atom of glass entered his eye.

This shows that the danger is not so much, as many believe, from small pieces of glass as from all the glass being driven through the frame and cutting through the eyelid and eyeball. The safety flange above referred to has been approved and adopted by many of the largest industrial companies in the world.

National Officers of the M. E. B. A.

At the fortieth annual convention of the National Marine Engineers' Beneficial Association, held at the Raleigh Hotel, Washington, D. C., January 18 to 23, the following officers were elected for the ensuing year:

President, A. Bruce Gibson, 17 State street, New York.

First vice-president, E. M. Roberts, E. Main street, Stratford, Conn.

Second vice-president, C. M. Vosburgh, 6323 Patton street, New Orleans, La.

Third vice-president, Wm. C. Wilson, 6029 Lansdown avenue, Philadelphia, Pa.

Secretary, Geo. A. Grubb, 1040 Dakin street, Chicago, Ill.

Treasurer, A. L. Jones, 38 Avery avenue, Detroit, Mich.

Personal

Peter Deitz, chief engineer of the tug *Yosephie,* is at the Gordoner ice plant at Schodack Landing, N. Y.

William F. Brookes has succeeded William Blunk as chief engineer of the river steamer *America,* at New Orleans, La.

Charles B. Hulsapple, chief engineer of the large towing steamer *Osceola,* was stricken with a serious illness at the Paterson ice plant at Van Wie's Point, New York, January 15.

William Hurst has been appointed assistant engineer on the steamer *Slack Barrett,* of the Barrett Towboat Company, Cincinnati, Ohio.

James Featherly, first assistant engineer of the Hudson River steamer *Ed. F. Murray,* is at the American ice plant, Poolsburgh, N. Y.

Joseph J. Blunk has been appointed chief engineer of the floating plants of the New Orleans Electro-Welding Company, New Orleans, La.

John E. Burlingham, chief engineer of the fast Hudson River freight steamer *Ed. F. Murray,* is employed at the McCabe ice plant at New Baltimore, N. Y.

Ambrose Van Wie, first assistant engineer of the Great Lakes tug *William H. Kinch,* is at the Venezuela ice plant of the American Ice Company at Stuyvesant, N. Y.

Naval Constructor William McEntee has succeeded Naval Constructor D. W. Taylor in charge of the experimental towing basin at the Washington Navy Yard.

A. Caulson, F. Cutchia and Joseph Cody have been appointed first, second and third assistant engineers, respectively, on the American steamer *Montana,* at New Orleans, La.

J. H. Reynolds has been appointed chief engineer of Captain W. L. Berry's new steamer *White Spot,* which recently left Paducah, Ky., on her maiden trip up the Tennessee River.

Patrick J. Killion, chief engineer of the United States Government tug *Colonel Thayer,* will be engaged in government service on the Harlem River, New York city, during the winter.

William C. Claflin, chief engineer of the tug *Florence W.,* of the Randerson Dredging Company, has accepted a position for the winter months at the Barnett Wool Shoddy Mill at Renssalaer, N. Y.

Frank Good has been appointed chief engineer of the river steamer *Barrett,* of the Barrett Towboat Company, Cincinnati, Ohio, now under charter to the West Kentucky Coal Company for towing coal to the southern ports.

Rear Admiral Frank E. Beatty, who has been in command of the third division of the Atlantic Fleet, and was formerly commandant at the Washington Navy Yard, assumed the duties of commandant at the Norfolk Navy Yard on January 4.

Sir Raymond Beck has been elected chairman of Lloyd's for the year 1915, succeeding Sir John Luscombe. Sir Raymond Beck was chairman in 1910 and 1911 and he served on the committee which prepared the State scheme of insurance of British shipping in time of war.

John B. Van Alen has been appointed chief engineer of the steel tug *Clinton,* of the Miller & Fields Dredging Company. This company has a five-year contract at Philadelphia, Pa., and the dredging outfit will leave Albany, N. Y., at the opening of navigation on the Hudson River.

Captain John Bernhard Arntzen, 63 years old, owner and master of the ferry steamer *City of Cairo,* died recently at Paducah, Ky., after a long illness. Captain Arntzen was formerly engaged in the ferry business at Cairo, Ill., and had a wide acquaintance among the western river boatmen.

Roy L. Peck, master mechanic of the Great Lakes Dredge & Dock Company, Chicago, Ill., recently made his semi-annual visit to the company's plant in the lumber district at Albany, N. Y. Mr. Peck was formerly a government steamboat inspector at Chicago, and a chief engineer of steamers on the Great Lakes.

Edward L. Latham, chief engineer of the river steamer *St. Louis,* is superintending the erection of the machinery for a new boat for the St. Louis & Tennessee River Packet Company, which will operate from Riverton to Florence, Ala. Mr. Latham will be engineer of the new steamer until the *St. Louis* starts out again in the St. Louis and Tennessee River trade.

James E. McCormick, a retired marine engineer, died in New York city December 30 at the age of seventy-six. Mr. McCormick was born in Albany, N. Y., and was originally on the Hudson River steamer *Old Belle,* of the Cornell Steamboat Company. Later he was with the Morgan Line, and before his retirement from active service he was for fifteen years employed on the steamers of the Iron Steamboat Company, New York.

Naval Constructor R. M. Watt, formerly chief of the Bureau of Construction and Repair of the Navy, assumed the duties of industrial manager at the Norfolk Navy Yard on January 11. The other officers assigned to the Norfolk Navy Yard are Naval Constructor W. G. Du Bose, construction superintendent; Naval Constructor George S. Radford, shop superintendent, and Lieutenant Commander Henry E. Lackey, engineer superintendent.

Samuel Hutton, chief engineer of the steamer *Betty,* working on the United States Government dam at Troy, N. Y., had a narrow escape recently when the *Betty* foundered in 30 feet of water. Mr. Hutton was rescued by the government employees. One other vessel, the United States Government steamer *Gen. Totten,* was also sunk in the river at this dam. These boats were engaged in breaking the ice which was forming around the new work and it will now be impossible to continue the work until spring.

Ezra Nicholson, inventor of the Nicholson recording ship log, died recently at his home in Lakewood, Ohio, aged eighty. Mr. Nicholson was educated in the public schools, at Berea College and later at Urbana University. In his early life he was engaged in horticulture. He saw active service in the Civil War and at the close of the war he became president of the Rocky River Railroad, a steam suburban road running from Cleveland to Rocky River. Mr. Nicholson later established part of the Nickel Plate Railroad. With the incorporation of the city of Lakewood (Ohio), Mr. Nicholson became its first clerk and treasurer and was prominently identified with the growth of the city.

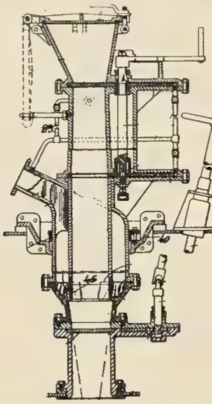
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,112,151. UNDER-WATER ASH-EJECTOR. JOHN F. METTEN, OF PHILADELPHIA, PA.

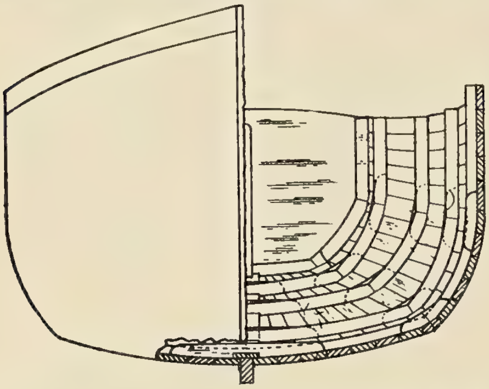
Claim 1.—In an ash-ejector adapted to discharge below water level, the combination of a tube opening through the ship below the water level, a casing connected with said tube and containing movable gates



adapted to open and close said tube, seats for said gates comprised between sections of said tube, said gates being spaced from said seats, and means for discharging water over said seats into said tube. Fourteen claims.

1,116,724. HULL FOR MARINE CRAFT. FRANK NICHOLAS, OF MONROE, NEW YORK.

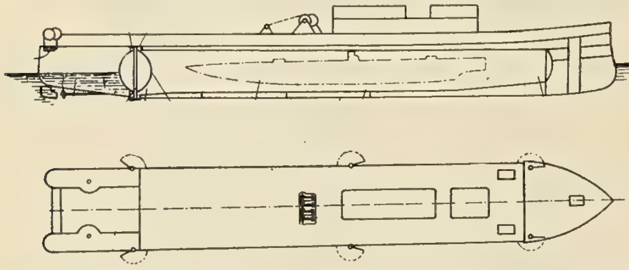
Claim 6.—In a hull for marine surface craft having hull-sections set at an angle to each other, the combination with the keel and deck-plates



thereof, of a series of chine-pieces arranged between said keel and deck-plates substantially parallel therewith, and circular-arc ribs extending transversely between said series of chine-pieces and the keel, between said series of chine-pieces and in the deck plates, and also between the various individual chine-pieces of said series. Six claims.

1,113,450. SUBMARINE TENDER. CESARE LAURENTI, OF SPEZIA, ITALY, ASSIGNOR TO SOCIETA FIAT-SAN GIORGIO, OF SPEZIA, ITALY.

Claim 1.—A tender or lighter comprising an inner shell adapted to be closed watertight by a floating door at one end thereof is in the form of a single hull and for another portion of its length projects beyond the aforesaid open end of the inner shell in the form of twin



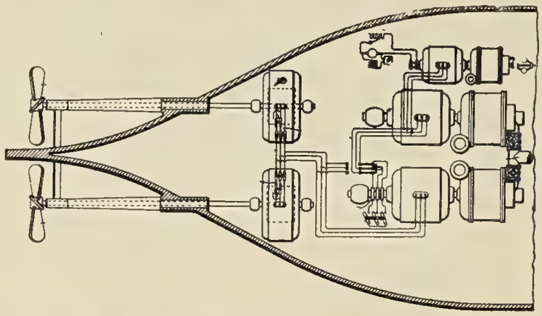
hulls connected together by a bridge or like frames, said floating door being lenticular in shape and adapted to be floated into position and provided with lugs or the like, said shell being provided with recesses provided therefor at the open end thereof through which said lugs on the door are adapted to pass when the door is in its longitudinal and slanting position, which recesses will be covered by said door when the door is in the upright transverse position so that in the last-named position the door will close the inner shell watertight either from without or from within as required. Seven claims.

1,111,139. TORPEDO-PILOT BOAT FOR AUTOMOBILE TORPEDOES. SLOAN DANENHOWER, OF BRIDGEPORT, CONN.

Claim 12.—The combination with a submersible torpedo-pilot boat having two pontoons furnished with fin-keels and provided with a single central control-compartment, of an automobile torpedo detachably supported by and between said keels, and independent means operable from said compartment for starting the propelling mechanism of the torpedo and for releasing it whereby it may travel independently of the boat. Thirteen claims.

1,118,382. PROPELLING SHIPS BY POLYPHASE ELECTRIC CURRENT. ELIHU THOMSON, OF SWAMPSCOTT, MASS., ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

Claim 1.—In a system the combination of polyphase generators of the induction type, said generators having stationary armatures and ro-



tating fields that are mounted on separate shafts, an auxiliary synchronous generator for fixing the frequencies of the poyphase generators, means for varying the speed of the auxiliary generator, electrical connecting means for connecting the main generators to operate as induction generators in parallel under certain conditions, and means for connecting the main generators in concatenation so that one generator operates as an excited field generator for other conditions of operation. Three claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

10,734/1914. ANTI-FRICTION BEARING FOR THE JOURNALS OF COMPASS BOWLS. W. D. WHYTE, 96 HOPE STREET, GLASGOW.

Claim—The object of the invention is to obviate the use of rollers which have heretofore been employed. The improved bearing comprises two or more balls held in position in a semi-circular cage, formed in two parts connected together by cross pins, the balls being so set in countersunk holes in the parts as to be free to revolve. The balls are of a diameter greater than the width of the cage. The cage itself is set, as usual, in a recess in the gymbal ring or in the binnacle flange, as the case may be.

24,971/1913. IMPROVEMENTS IN DAVITS FOR SHIPS BOATS. J. R. BARNETT WESTERFIELD, RALSTON AVENUE, ROOKSTON, RENFREWSHIRE, SCOTLAND.

Claim.—Consists of a pair of davits curved to an inboard direction to suspend the ships boat and hinged to the deck of the ship, thus putting the boat inboard and outboard and operated mechanically by a handle and screw gear connected with a double span to the pair of davits.

25,085/1913. IMPROVEMENTS IN TELESCOPIC MASTS. T. D. SMITH, BAROON FALLS VIA NAMBOUR, QUEENSLAND, AUSTRALIA.

Claim.—A telescopic mast having a sheath and telescope sections adapted to collapse within same, characterized by a casting to enclose a gag rope around the mast sheath, and gearing adapted to rotate the reel and simultaneously raise the mast sections.

6,028/1914. IMPROVEMENTS IN RUDDER PINTLES. J. M. RAMSAY, ELBERRY IRVINE ROAD, KILMARNOCK, AYRSHIRE.

Claim.—Consists in the arrangement of the nut fastening, the pintle being placed upon the upper side of the sternpost gudgeon, and the pintle being so shaped that it can be withdrawn downwards; the position of the rudder gudgeon being above the fastening nut.

7954/1914. IMPROVED COMPOSITION PRINCIPALLY INTENDED FOR COATING SHIPS' DECKS AND LIKE FLOORING PURPOSES. SIR. A. DENNY, OF THE FIRM OF W. DENNY & BROS. OF LEVEN SHIP YARD, DUMBARTON, AND D. G. ANDERSON, 10 WENDOVER CRESCENT, MOUNT FLORIDA, GLASGOW.

Claim.—In forming the improved composition, all the solid ingredients used are first intimately mixed together, and sufficient water added to form a stiff granular paste which is spread on the surface to be covered, then stamped down and surfaced by trowelling all in the usual manner. With the water there may be added a dilute solution of sodium aluminate. As indicative but not limitative the following example is given in parts by weight. Gypsum cement, 100 parts; Portland cement, 15 parts; pumice, 20 parts, and sawdust 20 parts.

11,503/1913. "IMPROVEMENTS IN MARINERS' COMPASSES." KELVIN & JAMES WHITE, LTD., AND OTHERS, GLASGOW.

A mariner's compass having an optical system including magnifying and reflecting means supported independently of the compass bowl and capable of use when the binnacle hood is in place, said magnifying means being constituted by a lens or lenses used as a reading glass, or other means optically equivalent thereto, said optical system being adapted to present to the observer a vertically, or approximately vertically, disposed magnified image of a substantial segment of the card, along with an image of the lubber mark, without the intervention of a screen and without reversal of the markings on the card.

International Marine Engineering

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Marine Terminal Equipment In devoting this issue to the subject of marine terminals we have taken up only that phase of the subject which applies to the economical handling of miscellaneous freight. Considering the slow and expensive methods of loading and discharging vessels that prevail in most American seaports, and the resulting congestion and delays that occur in handling shipments, the importance of the subject at once becomes manifest. In general, European ports are extensively equipped with freight-handling machinery designed to lower the cost of handling freight and to decrease the time vessels are required to remain in port for receiving and discharging cargoes. The methods adopted in European ports, however, have been developed to meet existing conditions, and in most cases cannot be applied directly to the conditions existing in the average American seaport. The physical characteristics of harbors and the local conditions prevailing in transportation systems must first be considered before determining the most desirable and most economical equipment for a marine terminal. In every case, however, the solution will be found in the application of some form of machinery to supersede manual labor.

Western River Terminals At no place in the United States has progress in the development of marine terminals been so retarded as on the Western rivers, where in recent years the once prosperous steamboat packet business has dwindled to an insignificant amount. In accordance with the customs handed down from the days before the Government improvement of the rivers was begun, the sloping bank of the river at any convenient place still constitutes a steamboat landing, except in the large cities where paved levees and floating wharves are used. That merchants and city officials are awakening to the fact that the only way in which the river steamboat traffic can be successfully fostered is by the establishment of adequate terminals at the large cities along the rivers, with suitable railroad connections, is shown by the river terminal conference which was held recently in St. Louis. The conference has now become a permanent organization to encourage the development of adequate terminals along the Mississippi, Missouri and Ohio rivers, and there is every prospect that material results will accrue from the plans and suggestions discussed at the conference. As pointed out in a paper read before the conference by H. McL. Harding, speed in loading and discharging freight and the reduction of time of detention of the vessels are the chief factors in the successful operation of a marine terminal and for river terminals the type of machinery best adapted for rapid and economical handling of freight is some form of vertical hoist installed on quay walls, so that the freight can be hoisted directly from the barge and conveyed to the terminal shed or warehouse.

Award of Prizes in Engineers' Contest The first prize in the contest for the best letters sent to this journal before January 1 by practical marine engineers has been awarded to Lieutenant G. J. Meyers, chief engineer of the United States battleship *Rhode Island*, for a letter on "Economy of Coal and Boiler Corrosion." D. Sawyer, chief engineer of the steamer *Northland*, of the Norfolk & Washington Steamboat Company, Norfolk, Va., has been awarded the second prize for a letter describing an interesting change in a twin screw steamer, and Joseph Church, 2d, of Tiverton, R. I., has been awarded the third prize for a letter which relates his experiences with a keel condenser. The prize-winning letters will be published in our next issue, and these will be followed in later issues by other letters submitted in the contest which are considered of sufficient interest for publication.

Prospects Bright for Shipbuilders Since early last December contracts for over fifty steam vessels, most of which are of several thousand tons deadweight capacity, have been placed with American shipbuilders, and inquiries are out for from fifty to sixty additional ships. The prediction made in our January issue, that favorable conditions would prevail in the American shipyards during the coming year, has been fully borne out, and the outlook, especially in the shipyards on the Atlantic coast, is better than it has been for many years. While the Atlantic yards are rapidly filling up to full capacity, the yards on the Pacific coast are also beginning to feel the stimulus of increased busi-

ness, and it is probable that in a short time an increased number of orders will be placed in these yards. As compared with the period covered by the last six months of 1914, when scarcely an order of any consequence was placed in an American shipyard, the outlook is most promising. Practically the only district that will not benefit directly by the increased demand for American-built ships is the Great Lakes, where the over-production of tonnage in recent years has reduced the demand for new vessels to barely enough to keep one or two yards engaged to even moderate capacity.

Retirement Allowance for Shipyard Employees

The Newport News Shipbuilding & Dry Dock Company has instituted a system of retirement allowances for its employees that should benefit greatly not only the employees at the yard, but also the company itself. All employees of the company are eligible to receive the retirement allowance in accordance with the rules and regulations prescribed by the company. The allowances are voluntary gifts on the part of the company, and the continuance of their payment depends upon the earnings of the company, and of course may at any time be reduced, suspended or discontinued, if it is found necessary to do so.

The allowances are granted by a special board consisting of the general manager of the yard and two other members appointed by him. All allowances granted under this plan are unassignable, and they are paid only to those employees who have given their entire time to the service of the company. Retired employees, however, are held to be no longer in the employ of the company and are at liberty to engage in other business. The payment of the allowance, however, will be discontinued if the business engaged in is considered prejudicial to the interests of the company.

The amount of the retirement allowance is based on length of service. For each year of service with the company the allowance will be one percent of the average yearly pay received during the last ten years of service, the amounts being paid in monthly installments. The length of service on which the allowance is based is reckoned from the date since which the employee has been continuously in the service of the company to the date when retired.

Subject to the rules prescribed by the company, retirement allowances will be given to (1) men who have been twenty-five years or longer in the service of the company and who have reached the age of sixty-five years, (2) women who have been twenty years or longer in the service of the company and who have reached the age of fifty-five years, (3) men who have been in the service of the company thirty years and who have reached the age of sixty years, and (4) women who have been in the service of the company thirty years and who have reached the age of fifty years. Retirement of employees, with allowance, when the specified length of service has been reached, is optional with the employee or with the company, although employees in executive or administrative positions may be allowed to remain in active service after reaching the ages specified for retirement.

Nationality of Vessels Carrying American Commerce

According to a recent statement made by the Secretary of Commerce, the aggregate value of the water-borne commerce of the United States, including imports and exports, in the fiscal year ended June 30, 1914, amounted to $3,785,469,000 (£776,000,000). Of this, 53.45 percent was carried in British vessels, 13.79 percent in German vessels, 9.26 percent in American vessels, and the remainder in smaller percentages in vessels of other nationalities. From July to December, 1914, the total value of the water-borne commerce was $1,660,761,000 (£341,000,000), of which 52.54 percent was carried in British vessels, 14.09 percent in American vessels, 6.03 in Norwegian vessels, and the remainder in smaller percentages in vessels of other nationalities. Again, for the month of December, 1914, the value of the water-borne commerce of the United States amounted to $323,234,000 (£66,300,000), and of this 53.1 percent was carried in British vessels and 11.5 percent in American vessels. While the percentage of imports and exports of the United States carried in American vessels is gradually increasing, it by no means represents the gains which should be made under existing conditions if the United States possessed an adequate merchant marine for foreign commerce.

International Engineering Congress

From two hundred to two hundred and fifty papers and reports, covering all phases of engineering work and contributed by authors representing some eighteen different countries, have been assured for the forthcoming International Engineering Congress to be held September 20-25 in connection with the Panama-Pacific Exposition at San Francisco, Cal. In spite of the fact that the number of representatives from the countries involved in the European war will naturally be less than originally planned, the Congress, nevertheless, will be thoroughly international in scope and character. According to a report from the Secretary of the Congress, the papers are now rapidly coming in, and their character gives full assurance that the proceedings will form a most important collection of engineering data and a broad and detailed review of the progress of engineering art during the past decade. Invitations are now being issued by the Committee of Management to all important engineering societies of this country and abroad to appoint official delegates to attend the sessions of the Congress, and the presence of a considerable body of such delegates is well assured. Membership in the congress with the privilege of purchasing any or all of the volumes of the Proceedings is open to all interested in engineering work.

The Classification of American Ships

In his annual report for the year 1914 the Commissioner of Navigation gives a list of the steel vessels of 1,000 gross tons and over built in the United States and documented during the year ending June 30, 1914. This list comprises a total of 29 steel steamers aggregating 133,234 gross tons. Five of these vessels were ferry-boats and the remaining twenty-four included several oil tank steamers, two vessels for service in Chesapeake Bay, two Long Island Sound steamers, several American-Hawaiian vessels and three Grace steamships, while the balance were lumber, coal and freight steamships. Of these twenty-four ships nineteen aggregating 104,950 gross tons were classed by Lloyd's, and so far as we have been able to discover, only three, aggregating 13,369 gross tons, or about 10 percent of the total, were classed by other societies.

Further on in the report the Commissioner gives the names of the steel vessels building or contracted for on July 1, 1914. This list includes fourteen vessels, among which are a number of oil tankers, the two large passenger steamships *Great Northern* and *Northern Pacific*, and three or four colliers and freighters. Eliminating two ships that we understand are not classed at all, there remain twelve ships aggregating 96,880 gross tons building or contracted for on July 1, 1914. Of this tonnage, ten aggregating 77,580 gross tons were classified by Lloyd's and one by another classification society. The classification of the twelfth ship has not been disclosed. It will be noticed, therefore, that of the steel steamships, either building or contracted for on July 1, 1914, not one was classed by an American society.

From the foregoing facts it is very evident that the classification rules of the American ship classification society do not appeal to ship owners. It is not for us to decide where the trouble lies, but we do feel that it is necessary for us to call the attention of the marine interests of the United States to this apparent reflection upon American engineering ability, and we feel sure that our readers will agree with us that the services of American societies should be made suited to the uses of the ship owners of the United States, so that American-built and American-owned vessels need be classified only by an American classification society.

The Need of a Federal Law for Safe Ship Construction

The question of classing vessels leads up to another very important question, and that is, the legal protection of the lives of passengers and crews on vessels. So far as any federal law in the United States is concerned, we understand that there is no protection. Indeed, a man can build the flimsiest kind of a vessel, so far as interference by the federal authorities is concerned, provided he can find a shipbuilder who is willing to construct a vessel of that kind. Fortunately, there is probably not a builder in the country that would deliberately consider building a vessel that he did not regard as seaworthy. That, however, is because of regard for his own personal reputation and the reputation of his company rather than because of any law on the subject. Furthermore, if a man were to succeed in having a flimsy and unseaworthy ship built, he could not secure insurance except at a prohibitive price, if even at any price, so that again public sentiment and public appreciation of the eternal fitness of things takes the place of federal law. The recent International Congress in London, which discussed the question of safety at sea, took advanced grounds on the designing and building of ships. It seems as though it is the duty of the United States Government to pass laws requiring that ships be built which shall be constructed along the lines laid down in the report of this Conference, an abstract of which was published in our issue of May, 1914. The time has passed when any chances should be taken with the lives of either passengers or crew, and it ought to be the duty of the federal government to have laws put on the statute books at the earliest date possible requiring every ship to be so constructed as to give the maximum of safety.

One Advantage of a Naval Reserve

The conditions in the shipping field will be very radically changed by the present war. Even before the war broke out it was difficult to find enough sailors in Great Britain to man the ships, and even the Germans were unable to furnish all the men called for. For several years past it has been the policy on the British ships to replace British and other seamen with Lascars and other Orientals, who work for very low wages and who, to use a common sea expression, "Can live on the smell of an oily rag." Merchant ships that have depended upon labor of this kind have had only a few white men on board, and these were the officers and the engine room force. During the war hundreds of thousands of men will be either killed or incapacitated for working on board ship, so that when peace is declared there will be a greater demand than ever for seamen, and apparently they will to a very great extent come from the Orient. Something ought to be done in the United States to prepare for this condition. Years ago it was the ambition of the energetic young men on Cape Cod and the coast of Maine and other parts of the country to ship before the mast and work up from the forecastle to the cabin so as to become masters of ships. All this has been changed by the introduction of so many foreign elements in the forecastle, and, as the result, there is no practical training for men who serve in the merchant marine outside of the training on our school-ships. It is for this reason that Congress should include in any shipping bill a clause establishing a special naval reserve and offering inducements in the way of extra pay for all men on board ships entering the foreign trade who are American citizens to join this naval reserve.

Transfer Facilities at Marine Terminals

Plans and Designs for Equipment for Economical Loading and Discharging of Vessels at Marine Terminals

BY H. MC L. HARDING *

At marine terminals the most important feature of operating conditions is to secure the utmost speed of discharging and loading the vessels. After this comes economy, which, however, is often sacrificed by the employment of many men, chiefly in handling, to obtain this desired rapidity. These two features can only be secured by correctly planning the terminal with this end in view.

To produce successful results, it is essential that there should be a personal knowledge of what has been successfully accomplished elsewhere, particularly at foreign continental ports, with special reference to the specifications,

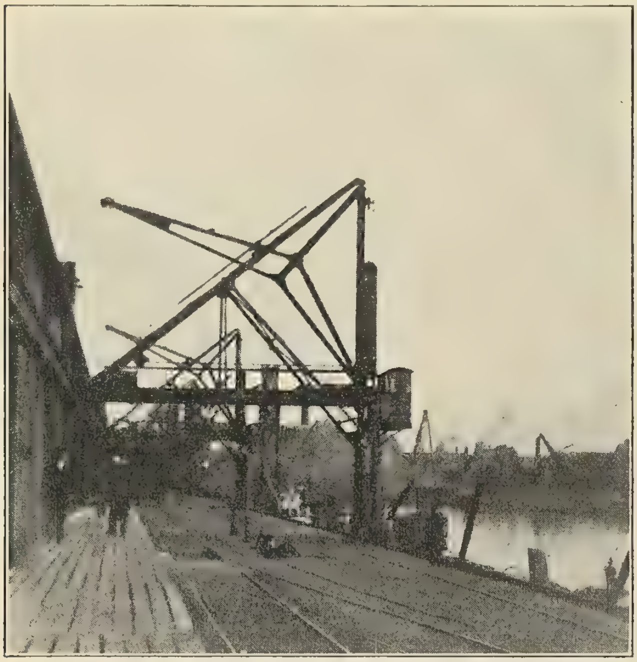


Fig. 1.— Traveling Jib Cranes Spanning Quay Wall Along River Weser at Bremen, Germany, for Transferring Freight to Distributing Shed or Cars, and the Reverse Movement

and to the guarantees of performance required by port authorities from the foreign manufacturers. It is difficult to obtain this information by reading, as in the little available literature much is obscured. To this must be added an acquaintance with the best American operating conditions which is possessed by many transportation superintendents and foremen. Unless there is this knowledge of foreign terminal conditions, of foreign package freight transferring and handling machinery, combined with an acquaintance with the operating methods in the United States, it is difficult to obtain speed and economy without congestion. To this lack of knowledge and experience has been due the unsatisfactory freight handling at terminals in this country. Marine terminal engineering should be founded upon world-wide knowledge and should not be provincial.

Definitions

Transference.—The direct movement between the vessel and the shore, in either direction, may be termed cargo-transference, and with this may be combined assorting.

Handling.—The freight movements in the vessel, or, upon the pier or within the shed, may be designated as "cargo handling." The handling movements may be divided into assorting, distributing and tiering, according to consignments. In the discharging movement for foreign commerce, the cargoes are generally lifted vertically by the ship's winch or by traveling gantry jib cranes.

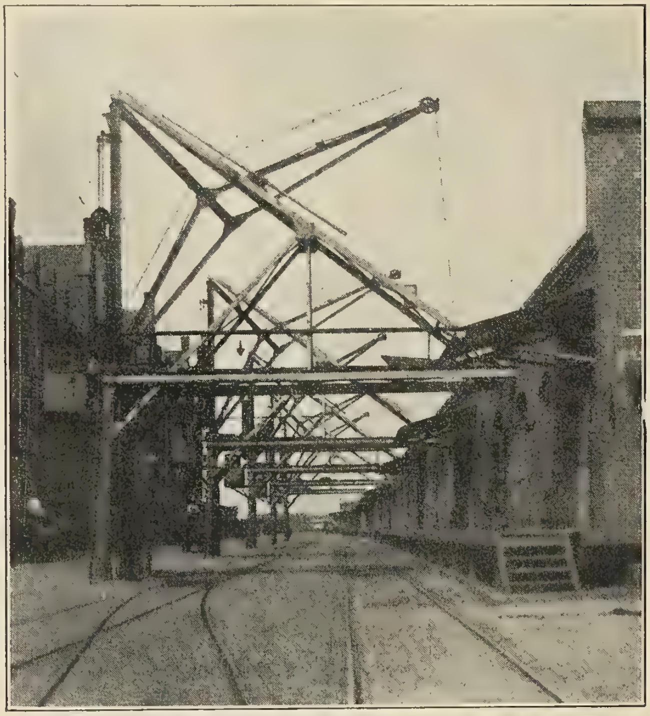


Fig. 2.—Rear of Distributing Shed, Showing Cranes for Transferring Freight by Direct Movement to Long-Storage Warehouse, Cars, Drays or Motor Trucks

Methods.—The fall rope of the winch is attached to a first boom, from the hook of which the draft is transferred by burtoning to the fall rope of a second boom and by it lowered to the side of the pier, whereby two drafts are in transference at the same time. The movement from the hold of the vessel to the pier is practically continuous.

In some cases the draft is burtoned to a fall rope suspended from the roof of the shed, attached to a second winch located within the shed or upon the pier, or else burtoned to the hook of a gantry jib crane or to the hook of an overhead traveling electric hoist.

Mechanical Transference Costs

If the gantry jib crane by itself raises the load from the vessel's hold, and deposits it upon the pier, or burtons it to hook of the traveling hoists, the cost of the mechanical movement of transference only, not including handling either within the ship or on the shore, with full loads, may be taken as averaging about three cents (0/1½) per ton.

If the transference be by one winch on the ship and another winch on the shore the cost will be increased to

* Consulting Engineer on Marine Terminals, New York City.

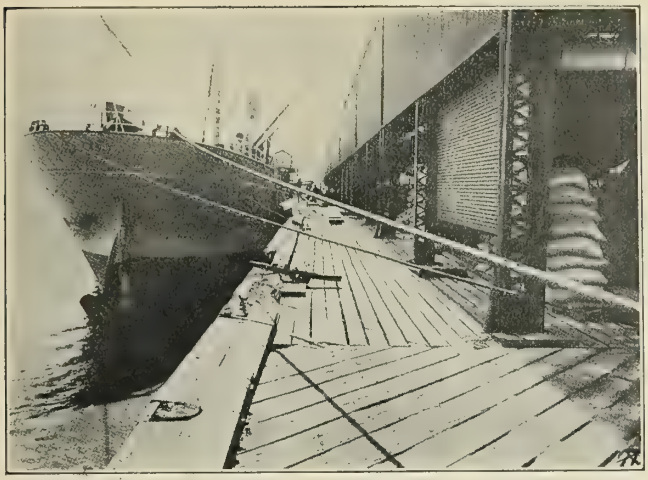


Fig. 3.—Typical Waterfront at New Orleans. Note Absence of Railway Tracks, Necessitating Trucking of Freight a Distance of 100 to 200 Feet to Railway Cars. Outbound Cargoes, Instead of Being Swung by One Movement from Car to Vessel at a Cost Between 3 and 6 Cents (0/1½ and 0/3) per Ton, Cost Between 25 and 35 Cents (1/0½ and 1/5½) per Ton or More for Handling. For Loading 1000 Tons of Freight this Represents an Unnecessary Cost of $3,000 (£616). The Condition of the Wharf, and Especially of the Decayed String Piece, Is Noticeable and Should Be Compared with the Concrete Quay Walls Illustrated in this Article

between five and six cents (0/2½ and 0/3) per ton, there being two winch crews.

If one mark only is raised at a draft, by which is accomplished the assorting, the above figures of three cents and six cents (0/1½ and 0/3) may each be doubled, respectively, to six cents and twelve cents (0/3 and 0/6).

As the gantry jib crane can serve a greater area, and prevent congestion at the place of deposition, by serving a greater area than is possible by the ship winches, data will be given concerning the performance of these gantry cranes.

Crane Transferring Capacity

Were it not for the hoisting of drafts of only one consignment, by which assorting is done, then from five hatches of a freighter with two cranes at each hatch, and with full loads, it would be possible to transfer 640 to 800 tons per hour. As most outbound freight from port to port requires no assorting, full transferring capacity can be attained.

Fig. 4.—Unloading Vessel at New Orleans. Cargo Moved by Manual Labor Up Inclined Aprons

Assorting

On account of transferring only one mark or consignment in each draft, thereby accomplishing the assorting, there would average 400 tons per hour, this lesser amount being due to the average lighter loads. It is, therefore, possible to transfer mechanically between vessel and shore between 640 and 400 tons per hour at a cost from three to ten cents (0/1½ to 0/5) per ton for the movements of transference by machinery. If assorting is done after transference, the cost for assorting alone will average from thirteen to sixteen cents (0/6½ to 0/8) a ton.

The handling or the second movements of distributing and tiering, the assorting having been accomplished, can be done best by machinery.

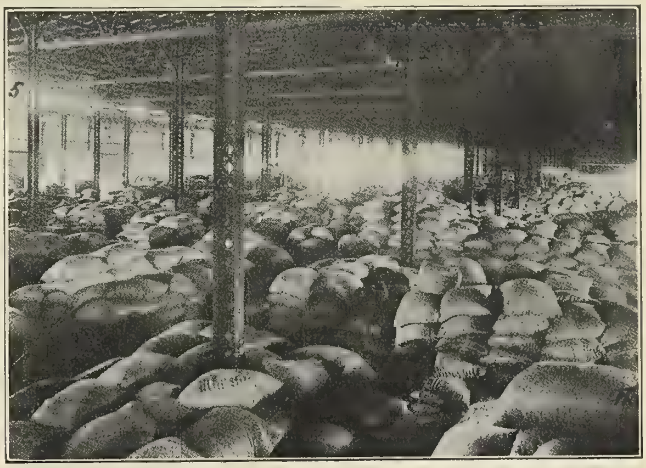


Fig. 5.—Steel Shed Filled (?) Only 5 Feet High Indicates Lack of Co-Ordination Between Vessel and Car. Cargo Deposited on Quay by Ship's Boom Must Be Trucked Through One and Sometimes Two Sheds to the Railway Cars

Manual Labor Costs

The cost for manual labor for distributing and tiering will be from twenty-nine to thirty-six cents (1/2½ to 1/6) per ton, including the handling in the hold. This variation, as in other cases, is due to the character of the cargo and the number of marks.

Mechanical Handling Costs

By mechanical handling by overhead traveling hoists for distribution and tiering, and the use of motor trucks for longitudinal distances, the cost can be reduced to twelve to fifteen cents (0/6 to 0/7½) per ton.

Through Overall Hatches

The vertical movement, as lifting, in regard to speed and economy, is of more importance than horizontal floor movement. This 640 to 400 tons per hour, through the overall hatchways, at a total cost from fifteen to twenty cents (0/7½ to 0/10) per ton can only be attained, as already stated, by correct planning.

Side Port Transference

With domestic commerce, carried largely by coastwise steamships, there has grown up the idea that speed and economy have been secured by transferring the freight by manual labor through side ports, or that in any event there is greater speed.

The origin of this practice was largely due to the passengers and freight being combined in the same vessel. As many large overall hatchways would interfere

with stateroom and saloon space, the side port transference was evolved.

As to the question of speed and economy the following is quoted from a report of the United States Government (House Document) prepared under the direction of the War Department:

"Along the Mississippi River, at the harbor of New Orleans, there is allotted to one steamship company a lineal berthing frontage of 2,100 feet extending from Dumaine to Conti streets, capable of accommodating four 450-foot vessels.

"There is a total of 209,680 square feet with sheds 141 or 80 feet in width.

"For the year 1912 the tonnage transferred and handled was 581,172 tons.

"The average cost through side ports for the year 1910 was 54.85 cents (2/3.4) per ton of 2,000 pounds on a basis of thirty cents (1/3) per hour for manual labor. Forty cents (1/8) per hour is paid for night and Sunday labor. The average time of loading and discharging is 125 tons per hour."

The utmost expedition is illustrated by citing the particular case of one steamship which was docked at 8:30 A. M., Jan. 25, 1913, and discharged through side ports 1,725 tons in eleven and one-half working hours, or an average of about 150 tons per hour, employing 355 men. This service included assorting, distributing and piling (tiering) in the sheds. The vessel was loaded with 2,831 tons in twenty-one and one-half working hours, or an average of 131 tons per hour, employing 200 men. The cargo consisted of miscellaneous package freight, and five ramps were used. The cost per ton was seventy cents (2/11) in this instance.

The average tonnage per lineal foot per year was 276.75 tons, which is excellent for manual labor. The following are lineal foot tonnage transferences per year for several foreign cities:

Bordeaux, 447 tons; Havre, 476 tons, and Marseilles, 564 tons.

Fig. 5.—Views of Various Types of Full Arch and Half Arch Traveling Gantry Cranes Operating on Concrete Quay Walls Transferring Miscellaneous Freight Between Vessels and Cars or Shed

The figures from New Orleans should be compared with figures of the official tests made by the port authorities of Montevideo, Argentine Republic, South America, as to hourly transferring capacity. The tests were made to decide as to the purchase of additional traveling gantry cranes.

These figures represented such satisfactory working of twenty traveling gantry jib cranes that an additional order was given for thirteen more cranes for the same harbor.

Costs of Transferring Freight at Montevideo

Capacity of cranes, 5,000 Kg = 11,025 pounds; lifting speed at full load = 24 meters = 79 feet per minute; revolving 1½ times per minute, equal to 130 feet at the hook.

The current consumption is figured for a cycle, consisting of the following movements:

Lifting 11,025 pounds out of the vessel 25.5 feet, revolving the crane through 120 degrees, lowering the load to the wharf, lifting the empty hook, revolving the crane 120 degrees to its original position and lowering the hook to the position from which it started. This was repeated a large number of times to get the average time per cycle.

The consumption of current at 500 volts D. C. was found to be 250 watt hours. At a cost of the current of three cents (0/1½) per kilowatt hour, the cost of moving 11,025 pounds through the above-mentioned cycle would be $250 \times 3 = 75$ cents (3/1½), or $\frac{2,000 \times .75}{11025} = .14$ cents (0/0.07) per ton of 2,000 pounds.

The time for one cycle was 70 seconds, to which 20 seconds were added for attaching and detaching the load, therefore the crane made 40 cycles per hour, making an output of $5 \times 40 \frac{2,205}{2,000} = 220$ tons per hour of 2,000 pounds for one crane. That with ten cranes would be 2,200 tons per hour.

These are official tests and guaranteed by the manufacturers. Instead of five-ton cranes, of which thirty-three of this type were installed at Montevideo, it is preferred to use two-ton cranes, with a reserve capacity and with the load of two tons at 160 to 180 feet per minute. Twenty-five hundred to 3,000 pounds at 180 to 240 feet per minute are common, and in the latest examples at Marseilles there were 300 feet per minute. It will be noticed that two tons at 180 feet per minute would approximate four tons at 79 feet per minute. The 640 tons per hour, as given, is, in comparison with the possible 2,200 tons per hour, conservative; and yet how great the 640 tons per hour, through the overall hatches, is to the maximum 150 tons per hour through the side ports, in the Federal Government Report as to New Orleans!

The three cents (0/1½) per ton is divided approximately into one cent (0/0½) for current, one cent (0/0½) for labor and one cent (0/0½) for amortization, interest and maintenance.

The above indicates most liberal figures for transference and are applied to the conditions in the United States. The total cost of mechanical transferring and mechanical handling through overall ports may be taken on the average from twelve to fifteen cents (0/6 to 0/7½) per ton, as compared with twenty-nine to thirty-six cents (1/2½ to 1/6) per ton by manual labor through overall ports, and with forty-five to fifty-five cents (1/10½ to 2/3½) per ton through side ports by manual labor.

Movement of Cargo to Warehouse

There is another movement of a portion of the cargo, viz., to the warehouse for long storage. If the inbound cargo be not removed from the pier or quay shed after forty-eight or seventy-two hours of free holding, it is then removed to the warehouse for long storage, the expense for moving and storage being at the expense of the shipper or consignee. There are, in addition, transference to other vessels, to cars and drays, both in loading and unloading. To obtain the figures given above of transferring and handling capacity and the costs, the plan of the terminal and the design and adaptation of the machinery are all important.

To illustrate one form of layout used extensively and efficiently on quays abroad, the accompanying illustrations are reproduced from photographs taken by the author: Figs. 1 and 2 show the quay, the shed and the warehouse of a foreign installation. Terminals in the United States, if equipped with the latest electric cranes and overhead traveling hoists, adapted to American operating conditions, both for transferring and handling, will fulfill the exacting conditions of speed and economy of package freight handling.

Fig. 1, taken on the Weser River, shows a concrete and stone quay wall, upon which is one crane rail, a half arch traveling gantry jib crane with its other supporting rail attached to the front of the shed, two railway tracks, and the front of the handling shed. The crane is hydraulic, but according to the latest practice, electric cranes are preferred to hydraulic. To obtain a better supervision of the hoisting and conveying movements the cab is now placed up in the jib members and moves with the jib of the crane. In many cases electric quay capstans are used for moving cars and vessels.

The platform in front of the shed, raised to the level of the railroad car floor with the shed floor at the same level, would be suitable if cranes alone are to be employed. The platform, however, would prove a barrier if the two-wheeled hand trucks or the small four-wheeled motor trucks should be used. It is preferable to have no raised platform, and the shed floor to be only a few inches above the level of the quay.

On account of the increasing use of the large motor trucks, in the place of horse drays and even railway cars, the space between the shed and the quay wall should be paved and the railway tracks should be flush with the surface of the pavement.

Fig. 2 shows the rear of the same shed, the to-be-discarded platform, the two railway tracks, which are here even with the surface of the pavement and the roadway for drays or motor trucks which can traverse any portion of the way between the shed and the warehouse.

It will be noticed that the half-arch hydraulic cranes are here not movable, possibly due to the difficulty of obtaining easy water connections with moving cranes. The number of cranes is more than would be required if the traveling electric cranes had been installed—probably double.

These cranes are of the half-arch gantry type of from two to three tons. The full-arch traveling jib cranes are preferable here, as such cranes can travel by their own power to other places on the quay where there are no sheds and where it is desired to transfer bulk material or single commodities not affected by climatic conditions.

Behind the roadway are the warehouses, which, though built for and used only for warehousing, have an impressive and pleasing architectural effect.

Inbound Cargo Movements

From the ocean steamship, from the barge or Rhine-boat, by means of the cranes, the drafts are raised and swung to the car or to the floor of the shed or upon a platform extending out from the front of the shed. If it is necessary to distribute according to consignments and then ship, this distribution is done within the shed and delivered to the cars located at the rear or in some cases in front of the shed. After the designated time (it may be forty-eight or seventy-two hours) the freight is swung by one movement of the crane from the shed to the platforms in front of any floor of the warehouse.

Outbound freight, generally not requiring assorting, is swung directly from the cars into the hold of the vessel by the cranes, or, if in the shed, similarly from the shed to the vessel.

CONCLUSIONS

First.—In the plan of a similar terminal, the salient features are the nearly vertical quay walls, the quay with its railway tracks and cranes, then the shed mechanically equipped and directly behind the shed the railway tracks, the roadway, the cranes and the warehouses.

Second.—The length of the shed should be about the same as that of the largest freighter, its width such that it will have a holding capacity with high tiering for the full inbound and outbound cargo of such a freighter.

Third.—On a projecting pier the shed should be in the center of the pier with ample space between the shed and the pier wall on each side.

Fourth.—The warehouses should be upon the shore and from four to six stories in height.

Fifth.—Unless a marine terminal is planned and designed for the installation of mechanical appliances, it will be almost impossible to secure the maximum mechanical efficiency.

Sixth.—By equipping a correctly planned terminal with properly designed mechanical appliances, the utilization of the whole terminal can be at least doubled.

Electric Trucking at the New York Terminal of the Southern Pacific Steamship Company

Savings of 78 percent in the cost of labor in transferring freight a distance of 1,000 feet on the Southern Pacific piers in New York were effected by the substitution of electric storage battery trucks for the hand trucks formerly used. Eighteen electric trucks were installed on these piers a year ago and now form a permanent part of the freight handling apparatus at this terminal.

Fig. 1.—Electric Trucks Handling Freight at Southern Pacific Piers

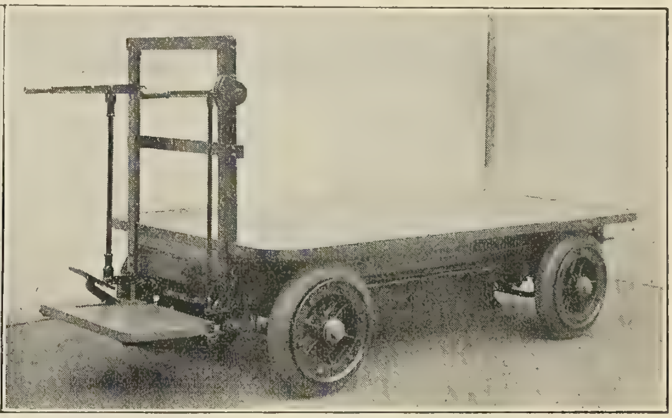


Fig. 2.—"Hunt" Two-Ton Electric Storage Battery Truck

The requirements at the Southern Pacific New York terminal are unlike those at many other steamship piers, in that the waterfront holdings of the Southern Pacific Steamship Company embody four piers, each 750 feet long by 125 feet wide with a total street frontage or "farm" 1,490 feet long by 50 feet wide, the latter area being used for the temporary storage of barrels of oil, rosin and molasses. The round-trip distances that a truck must make between the ship and the "farm" averages between 1,500 and 2,000 feet, and the distances from the ship to different points within the various pier sheds vary from 200 to 1,000 feet. The trucks are subject to rough service and are operated by longshoremen.

The truck installed is a two-ton capacity "Hunt" truck, manufactured by C. W. Hunt & Co., Inc., New Brighton, N. Y., having a clear platform of 4 by 7½ feet, or large enough to hold six barrels on end with strength sufficient to carry 100 percent overloads when occasion demands. The trucks have a speed range of from 1½ to 10 miles per hour. In brief, the two-ton "Hunt" truck can carry ten times the average load at four times the speed of a hand truck.

The following data compiled on actual operating costs give some indication of the vast improvement which has been made by the adoption of this method of handling freight at this terminal. The operating record established at the Southern Pacific pier No. 49 consisted of carrying 3,700 barrels of oil and rosin (400 of rosin) from pier 49 to the "farm," a round-trip distance of 2,000 feet per load in a total working time of 10 hours, employing 22 men; 12 men loading, 6 men operating trucks and 4 men unloading. The labor cost per ton amounted to .0775, as compared with .354 per ton for hand trucking, making a saving of .276 per ton, or 78 percent.

The trucks were loaded by sliding the barrels on skidways direct from the ship to the truck, and they were unloaded by rolling the barrels off on skids. Each truck carried 616 barrels, or a total weight of 142 tons, a distance of 39 miles in 10 hours. Each truck weighs 2,200 pounds, the battery consisting of 36 A-4 Edison cells of 160 amperes. The trucks were charged for one hour at noon.

ANNUAL MEETING OF THE INSTITUTION OF NAVAL ARCHITECTS.—The annual meeting of the Institution of Naval Architects will be held on March 24 and 25 in the Hall of the Royal Society of Arts, John street, Adelphi, London, W. C. Owing to the continuance of the war, the customary entertainments will be omitted.

MONTHLY SHIPBUILDING REPORT.—The Bureau of Navigation, Department of Commerce, reports 32 sailing, steam and unrigged vessels of 12,258 gross tons built and officially numbered in the United States during the month of January. Four of these vessels, aggregating 9,033 gross tons, were steel steamships, the largest being the *Northern Pacific*, built by the William Cramp & Sons Ship and Engine Building Company, Philadelphia, Pa., for the Spokane, Portland & Seattle Railroad Company.

CORRECTION.—On page 94 of our February issue the name of the inventor of patent 1,116,724 is erroneously given as Frank Nicholas. This should read as Frank Nichols, of Munroe, New York.

Freight Handling at Railway Marine Terminals

BY C. A. HARDY *

In an article contributed by the writer to this magazine a year ago, the design of a warehouse and dock in combination with traveling cranes inside and gantry cranes outside was shown. Since the previous article was published, railway and steamship men have suggested certain changes which are embodied in the sketch shown herewith.

It appears that many steamship lines only accept freight which can be handled by the ship's hoisting machinery. The ships are arranged so that the crew handle the freight in and out of the vessel, taking it from the wharf and depositing it in the hold of the ship, and when arriving at the destination, taking it from the hold and laying it on the wharf alongside.

Wherever this arrangement prevails it is advisable that the booms of the cranes and the legs of the gantry cranes on the wharf shall be set back from the edge of the wharf so that there is no possible danger of interference with the rigging of the ship during docking, or with the ship's derricks in loading and unloading. This arrangement is shown in the sketch.

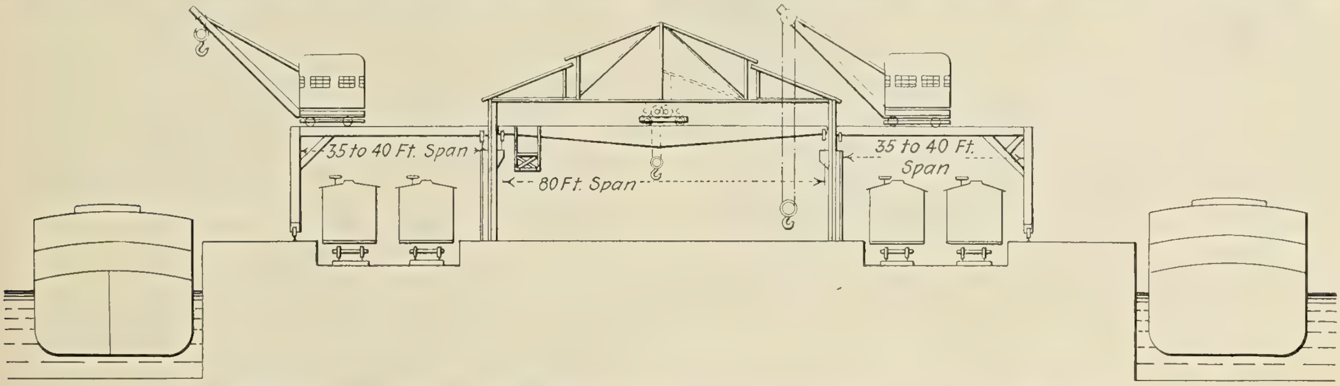
Railroad engineers have also suggested that the handling of freight can be greatly expedited by depressing the tracks to the level of the floor of the warehouse and the level of the wharf alongside. This practice is regularly followed in all the large freight terminals, and with this arrangement the package freight arriving in box cars can be easily trucked from the cars to the wharf and there picked up by the ship's derrick. Small package freight, placed by the ship on the wharf, can be trucked into cars for reshipment, without the use of the crane; and where merchandise arrives in box cars which is to be stored in the warehouse pending the arrival of the steamer this arrangement facilitates the handling of it materially.

By a suitable arrangement of bridges, which can be arranged to be operated electrically, package freight can be trucked back and forth from warehouse to ship, or from wharf to warehouse. With this arrangement electric storage battery trucks can be brought to the side of the ship and small package freight delivered therefrom directly to the ship's derrick without another handling. Freight taken from the hold of the ship can be dropped on these trucks, thus doing away with one handling. The storage battery trucks can then take the freight from the warehouse, the depressed tracks being provided, as stated above, with draw bridges, or drop bridges, at convenient points.

This arrangement also provides a roadway down the side of the wharf over which drays can deliver heavy package freight directly under the ship's cargo boom, thus doing away with another handling. There is no necessity of running teams through the covered portion of the dock. This will appeal strongly to anyone who has visited an old dock where drays and carriages run down the full length inside. The floor of the warehouse can be kept absolutely clean, and many of the disagreeable odors unavoidable where horses are used in a closed building are absolutely avoided.

Heavy package freight or machinery deposited on the dock from the boat, which is not subject to damage by weather, can be allowed to remain for transshipment, or until it is hauled away, and when hauled away the gantry cranes can be used to load it on the trucks.

A further development for the rapid handling of package freight, such as grain in sacks, cotton or other merchandise in bales, such as jute, hemp, etc., where the entire contents of the cargo consists of packages or bales of practically the same size, would be an arrangement of a belt conveyor or moving sidewalk whereby the necessity of trucking from the wharf to the warehouse would be done away with by depositing the packages directly from the ship on the conveyor; this conveyor to be arranged to reverse so that packages to be delivered from pier to ship could be rapidly conveyed to ship's side. A movable arrangement of this kind could be installed on a pier equipped as shown in the sketch, and handled by the gantry cranes.



Arrangement of Steamship Pier, With Overhead and Gantry Traveling Cranes, for Handling Freight

* Whiting Foundry Equipment Company, Harvey, Ill.

Handling Cotton with Electric Freight Trucks at Galveston

The success of the electric industrial truck as a substitute for the hand truck on steamship piers has already been noted in these columns, but the application of the "electric stevedore" to the handling of cotton at the compress may be something new to most of our readers. The Merchants & Planters' Cotton Compress and Warehouse Company, of Galveston, has a plant involving 28 storage compartments, an immense compress room, and 4 classing sheds, the total storage capacity being 100,000 bales. Approximately 300,000 bales are handled through the plant annually. The power trucking test made at this plant was probably the first of its kind.

A general vehicle electric freight truck with a 10-foot platform, manufactured by the General Vehicle Company, Inc., Long Island City, N. Y., was placed in service at

this plant on November 30, 1914, and all that day the truck averaged 25,000 pounds of material in the shape of "flat" bales of cotton per hour, over a 600-foot haul on a shell roadway. That is, over 40 bales of cotton were loaded, hauled 600 feet on shell roads, unloaded, and the truck returned light each trip for every hour of the working day.

"This service represents the work of eight men for the same period of time, using hand trucks," states H. J. Runge, Jr., a local engineer, "therefore cost of handling by 'dragging' would have required eight men for one-third hour at 25 cents (1/0½) per hour, or $2.65 (11/0½). The cost of operating truck is about 50 cents (2/1) per hour. Net saving effected by truck, $2.15

General Vehicle, 10-Foot Industrial Truck, Hauling "Flat" or Uncompressed Cotton from Storage Compartment to Press. Haul About 500 Feet

(8/11½). We expect to be able to show a net saving of $15 (3/2/6) per day through the use of the industrial truck."

When the enormous number of hand trucks in use at even the cotton ports of this country is taken into consideration, the opportunity for economies through the use of these "electric stevedores" becomes apparent and the compactness and flexibility of the elecertic make its use not only possible but advisable in freight terminals and manufacturing plants throughout the country. The use of such trucks is rapidly expanding, there being between two and three thousand already in use.

It has for many years been the aim of the General Vehicle Company to simplify the construction and hence the operation of all its vehicles. The truck has single reduction gearing, doing away with chains, internal gears and universal joints, etc. Self-lubricating roller bearings are used. The controller is enclosed and the automatic cut-off switches minimize accident. One handle is used as controller lever, and the other handle for steering. The controller returns to neutral as the hand is removed from the lever. The cut-off switch cuts off the power when the foot is removed from the brake pedal. In other words, the driver applies the brake simply by releasing the pedal with his foot, and as he releases the pedal the power is cut off automatically. The simplicity of operation does away with the necessity for hiring expensive operators, the average freight handler, colored or white, being taught, it is claimed, to operate the truck successfully, even in congested plants or terminals, in about 24 hours.

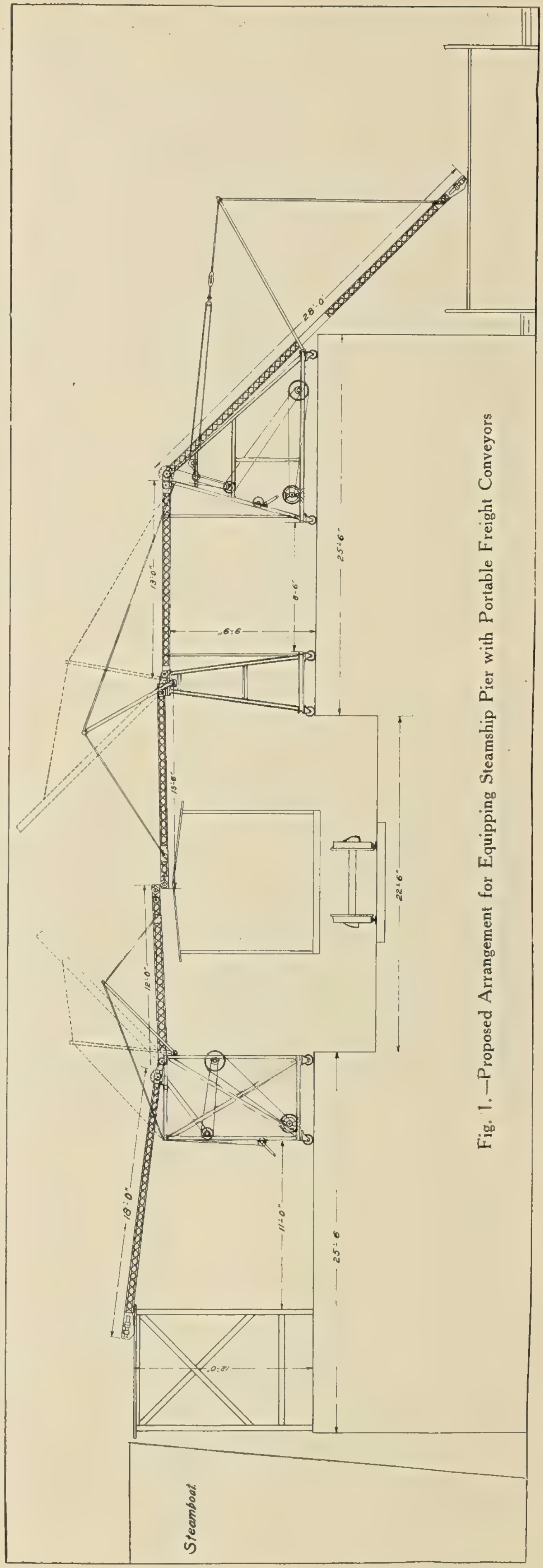


Fig. 1.—Proposed Arrangement for Equipping Steamship Pier with Portable Freight Conveyors

Unloading Cargoes by Portable Machines

The recent installation of portable and sectional unloading and conveying machinery by the Board of Commissioners of the Port of New Orleans warrants a careful consideration of the economic value of this type of equipment by engineers having charge of the work of unloading large quantities of materials from boats or cars. The problem presented in New Orleans was to cheapen and expedite the work of steamboat discharging and loading up and down a planked 20 percent grade 60 feet long, and delivering the packages to varying heights from the loading of hand trucks to the top of a pile on a motor truck. The problem also included loading and discharging steamships, transferring the freight between shed and deck practically on the level, but providing for the varying heights of decks, due to loading or water level. Further, the machines were to be arranged to be easily moved from one warehouse to another, or to be taken out of the way when not in use. The materials to be handled consisted of bags of rice, flour, coffee, Cuban sugar, cement, bales of cotton, cases of canned goods of various sizes, loose castings and machine parts and casks of molasses, the pieces running in weight from 95 to 700 pounds and varying as greatly in bulk and shape.

Fig. 2.—Conveying Cargo Up 20 Percent Grade by Manual Labor

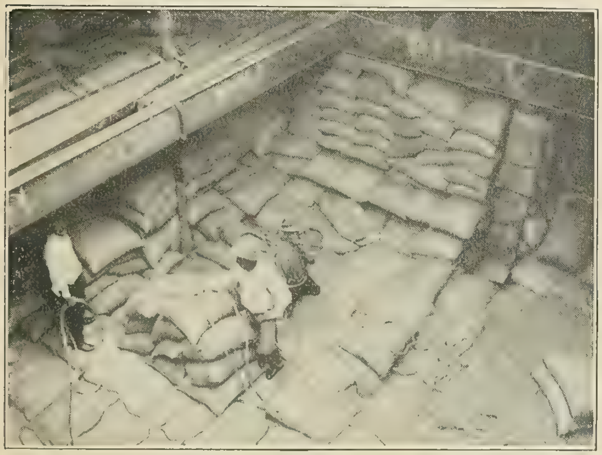


Fig. 3.—Making Up Sling Load in Ship's Hold

Fig. 4.—Cargo Loaded on Portable Conveyor at Ship's Hatch

The successful installation, made by the Brown Portable Elevator Company, of Chicago, consists essentially of two conveyors, one of the apron type for handling the bags, boxes and loose parts; the other of a "drop-axle" type, for handling the cotton bales and molasses casks. The former is of medium-weight construction and the latter of much heavier construction. The accompanying illustrations show the lighter conveyor; the other differing from this in general appearance only in the heavier type of construction.

It will be seen that the conveyor is made up of a number of sections, supported and connected by platforms, some of which carry the power units. The power is distributed over two, and in the case of the heavier machine, over three electric motors, instead of driving the entire equipment by one motor, as this simplifies the problem of portability. A light, portable crane, shown back of the machine in Fig. 5, is provided, and by using this, one or two men can disconnect all the sections and place them on the ground ready for moving in a few minutes, and

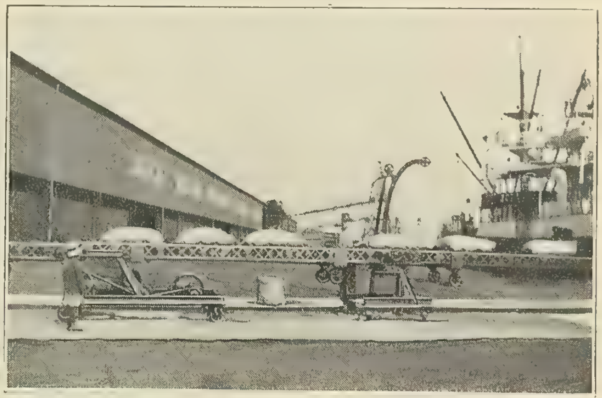


Fig. 5.—Transferring Cargo from Ship to Shed on Portable Conveyor

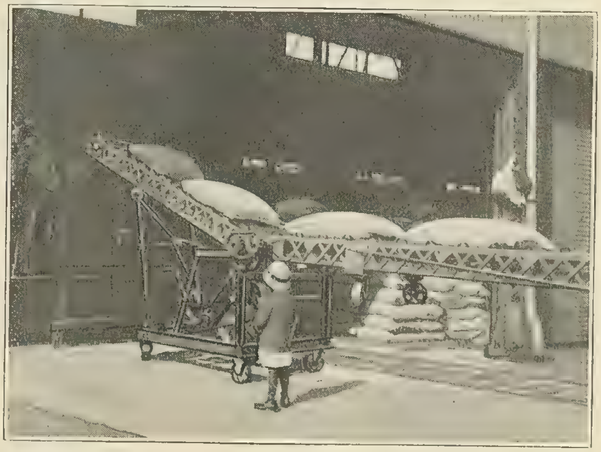


Fig. 6.—Shed End of Portable Conveyor, Elevating Cargo for Tiering

the whole equipment can then be drawn from place to place by the motor trucks. In the design of this equipment the Brown Portable Elevator Company took into consideration the fact that every steamboat is already

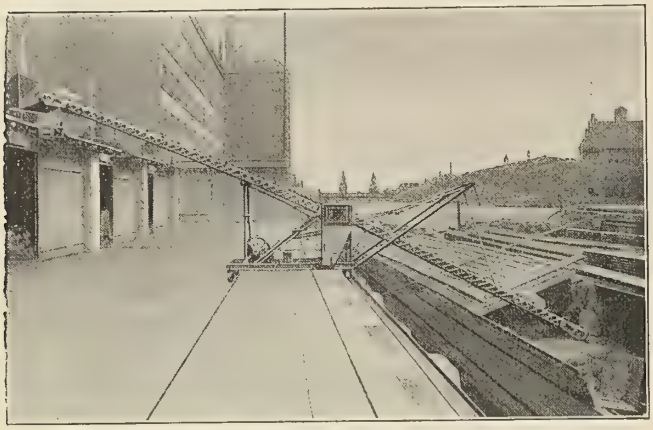


Fig. 7.—Brown Portable Conveyor at Decazeville, France

equipped with hoisting gear, so instead of attempting to bring the packages out of the hold, the ship's gear is used, which brings up a number of packages at a time, delivering them on a table on the deck, from which four men pass them to the conveyor.

The conveyor has a guaranteed capacity of approximately a ton a minute; and in actual work in its initial tests it was operated for five days hauling cement up the 20 percent grade of the Poydras street wharf, and exceeded this guaranteed capacity. Following this, it was

inside the warehouse, a distance of 100 feet from the steamer, at a rate varying from 206 bales the first hour gradually up to 300 bales per hour, which is the physical limit for feeding and disposing of the bales. This rate

Fig. 9.—Unloading Cement Steamer on Lake Erie with Brown Portable Conveyor, with One-Half the Labor and in One-Third the Time Required for Unloading by Hand

of handling not only reduces the cost by more than 50 percent, but it expedites it to such an extent that exceedingly little time is lost in the work of loading and unloading.

While this New Orleans equipment is a typical example of how the Brown Portable Elevator Company is solving

Fig. 8.—Brown-Portable Installation in Baltimore. This Equipment Takes the Bags Out of the Boat, Across the Warehouse and Piles Them to Any Height Desired, Without Any Intermediate Handling, Saving the Cost of Fifteen Laborers, Reducing the Time of Unloading One-Third, Overcoming the Confusion Caused by Truckers, and Making Valuable Much Hitherto Wasted Space

operated for three days on coffee, then followed lots of boxes, miscellaneous packages, loose singletrees and other hardware, and within five minutes after the completion of this work it was reversed and 900 bags of rice-hulls were taken aboard the barge.

The large machine in its first tests carried cotton bales of 650-pounds weight up the grade, delivering on trucks

some of the difficult conveying problems presented in terminal work, this company has been successful in placing machines in all parts of the world, and on account of the flexibility of their system it has been adapted with success to the handling of a great variety of packages ranging in weight from flour in 14-pound paper bags to bulky bales of scrap paper of 1,000 pounds.

Reservoir Effects in Freight Movements

Function of the Warehouse in Intermittent Movement of Freight—Extension of the Reservoir Principle to Mechanical Freight Handling Systems

BY ROBERT H. ROGERS *

In mechanics, wherever power is applied intermittently and a constant effect is desired or where both power applied and power transmitted are intermittent or varying, a flywheel is interposed for the purpose of reserving the surplus power and returning same to the system whenever the demand exceeds the supply. The flywheel storage capacity tides the system over its deficient moments.

In like manner, in transportation, the great warehouse systems of the coast cities and of cities bordering on great productive areas are designed to smooth out the peaks and valleys of supply and demand. The warehouses are constantly filling or discharging, completely or in part, to break the abruptness of commercial changes and are therefore valuable fixtures in the broad equipment of the traffic world.

The actual physical work required in the constant filling and emptying of these immense cellular reservoirs, the apparatus needed and used, as well as the proper coordination of the various systems of transferring, elevating and storing present an abundant field for study, and one in which the reward is certain and remunerative.

In a few instances very good results have been attained in the matter of service to warehouses, and in one case there is a great system of warehouses under construction for which the manner and means of all freight movements involved have been carefully laid out in advance and the entire design bent to make every movement simple, inexpensive and rapid. It is expected that this work, when completed, will prove beyond the shadow of a doubt that warehouses should be designed around the transportation facilities rather than to install the transportation facilities by a series of compromises after the warehouses are built.

The Pier Shed a Necessary Reservoir

A prominent example of an unavoidable reservoir in freight traffic is the class made up of the pier shed of the seaport and the railroad freight house. These come closer to the main current and are exceedingly numerous and vary greatly in size and manner of performing their duties. Primarily, they smooth out the misses that occur between two or more intermittent carriers, standing, as they do, at the point where the freight is shifted from one form of carrier to another. They are, essentially, flywheels receiving impulses and delivering impulses remodeled as required for the moment.

Fig. 1.—Ships Aggregating Three Million Cubic Feet Capacity Can Dock in This Slip at Once

Freight almost never, however desirable, passes directly from dray to car, from car to ship, from ship to car, or car to dray; always there is at least the freight house or wharf interposed. To ignore or to eliminate this essential element in plans is to insure defeat. Admitting the necessity of these pools, it is best to work them into the scheme to advantage and amplify their usefulness.

Transfer terminals of the railroads, when less than carload lots of package freight are transferred from car to car, do not act as reservoirs, for in modern freight practice the freight is not put down at all from car to car. This is so conspicuous an exception that it goes far to prove the rule.

A continuous contact of years with terminals has so far failed to show an instance of package freight, other than perishable fruit, passing directly from ship to car or vice versa. There is the fact that freight cars bring small loads intermittently from many points, while the hold of a great ship requires an enormous amount of freight practically all at once to satisfy its appetite—hence the pier shed becomes an accumulator as a more economic principle than holding the ship for the leisurely arrival of its outward cargo.

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* Consulting Engineer, General Electric Company, Schenectady, N. Y.

Another consideration of a purely business nature adds to the certainty and perpetuity of the intermediate storage, and that is the matter of checking, weighing, inspecting, sampling, recoopering, etc. To the engineer it would seem as though much of this mauling and man-handling of freight could be avoided or done once for all by some but practice with many old and modern methods and devices has proved again and again that whenever two system or devices are working in series and one or both are of a pulsating or intermittent nature, a reservoir is in order at the junction to permit the full and steady operation of the whole system without delays and congestion.

Fig. 2.—Freight Warehouses at the Seaboard Have a Broad Economic Value

mutual agreement. This phase of freight handling could well form a chapter by itself, for the disturbance recurs at every turn and twist of the traffic and must greatly affect the overall cost of transportation, as it surely does the dispatch.

Having brought attention to the principal reservoirs now existing and the why of their being, we will turn to the desirability of introducing still more pools, flywheels or reservoirs, as they may be called, where freight is actually being moved. This may seem a long way from the usual mode of attacking freight handling problems,

Reservoirs in Mechanical Freight Handling Systems

As an illustration, a coffee ship is discharging by means of two whips in series onto small four-wheeled hand trucks. Enough hand trucks and crews are provided to haul away the output of the whips; but due to the human equation, the trucks become grouped, so that at times they wait in line for their loads, only later to leave the ship unserved, and the whips must wait for the return of the head of the line. This state of affairs is shown by the two sling loads on deck in Fig. 5, but, unfortunately, the picture does not show the idle gang in the hold. A sloping

Fig. 3.—Wharf Shed Filled with Lemon Cargo to Be Forwarded by Rail

Fig. 4.—Portable Conveyors Furnish a Reservoir Effect by Virtue of Their Capacity

stage of two or three truck loads capacity eliminated this trouble and boosted the output to the limit of the whips. In this connection it may be mentioned that a portable conveyor offers a still better solution, first, because it affords a continuous instead of an intermittent service, and second, because it is inherently a reservoir by virtue of its surface velocity being greater than the feeding capacity of the whips, thus constantly presenting a clean surface alongside the hatch.

Fig. 5.—Lack of Reservoir Between Systems Handicaps the Work of Discharging

In a case where a portable conveyor was used to bring cement from a barge up a levee bank to discharge onto industrial trucks for a rather long haul to various piles a similar scheme was adopted, as it was found necessary either frequently to stop the conveyor or litter the floor with cement, which interfered with the electric trucks. A smooth inclined stage of one and one-half truck-loads capacity furnished the needed flywheel effect, so that space was always available for discharging the conveyor and every truck found sufficient accumulation for quick loading.

Another kind of conveying apparatus, namely the tractor and trailers, has in itself considerable capacity by virtue of using three times as many trailers as are towed at one time by the tractor.

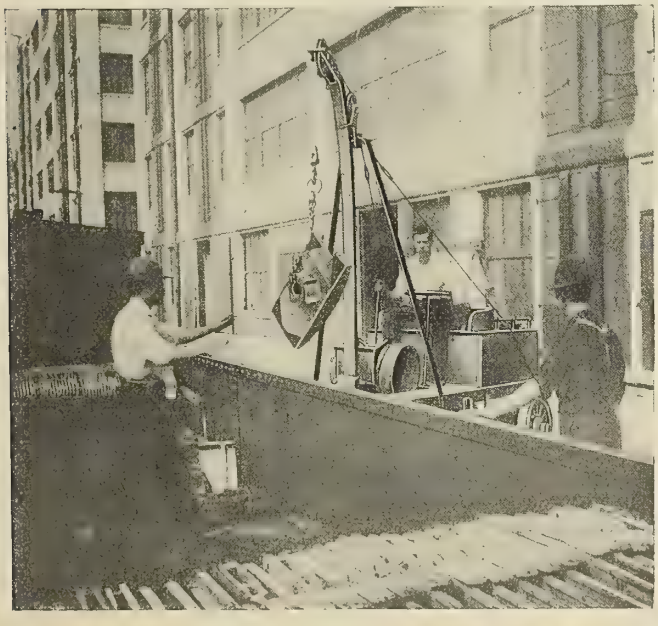

Fig. 6.—Warehouses Hold Railroad Freight for Future Savings

An elaborate and expensive special freight handling machine is brought to mind, in this connection, the failure of which was largely brought about by the lack of any latitude at the discharge end. Mathematical precision was required of the operators at that end, hour after hour, and the eternal human equation not being timed by cams to function at precise instants over long periods of time, nearly wrecked the machine, repeatedly damaged the merchandise and made the work at that end very unpopular. Neither was there any optional capacity provided at the feeding end, and as a consequence the theoretical and guaranteed capacity was quite impossible of attainment.

Commerce is of a willful nature and its appurtenances have not been chosen and held onto through these many years without good reason. To attempt to regulate its comings and goings, its upstandings and downsettings, to accommodate the Utopian ideas of the remote designer is futile and harmful to the general spread of mechanics in freight handling.

For a generation, probably, the general scheme of commercial and traffic inter-relations will change but little, and it is certain that much can be done to reduce costs and better dispatch by the use of machinery—if the present methods are carefully studied and the apparent handicaps are circumvented and made to aid the work in hand.

Marine Terminal Machinery

BY HARRY SAWYER *

While it seems probable that the near future will see rapid development in package freight handling machinery at our American ports, there has been but little progress during the past year to indicate the direction that development will take. A review of the situation and of the factors that must enter into the solution of the problem may be of interest at the present time.

Among the more important factors may be mentioned: Theoretical requirements, present American practices and development in foreign ports. If a clear analysis of our conditions and requirements could be made and complete independence of precedent be granted, the best results might be expected; but however much the engineer might like to attack the problem unhampered, he must recognize extraneous conditions which may prove to be the controlling factor.

Many contend that the common method of handling freight by "burtoning," or swinging the load by the use of two lines, both operated by the ship's winches, is the best. The tendency on the part of some to follow in the paths of European progress is seen in preliminary designs for American piers where the swinging crane mounted on the portal or semi-portal base is shown. But there are reasons why care should be exercised in this course: First, the crane equipment of European ports may not be the best for the conditions there existing; and, second, if well adapted to requirements, it still may not be suited to the needs of our American ports, where somewhat different conditions are encountered.

Cranes at Hamburg

In Hamburg several hundred cranes of the semi-portal swinging type have been installed for handling miscel-

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* Consulting Engineer, The Shaw Electric Crane Company, Muskegon, Mich.

laneous cargo. This foreign port has been compared to our American ports with parallels and contrasts to show that we should and should not so equip our marine terminals. Two local conditions are mentioned in explaining the extensive use of cranes in Hamburg, the great variation in river stage which makes it difficult or impossible to handle freight to and from the quays with the ship's tackle, and the use of barges that must travel under low canal bridges and cannot therefore carry masts for use in handling cargo. While these conditions do not obtain in all our American ports, they are not without parallels in this country. The New York State barge canal is spanned by bridges having a clearance of 15 feet 6 inches above high water, and barges using this canal will not carry masts. The tide variation in some of the Pacific Coast ports exceeds the variation in river stage at Hamburg, reaching 20 feet at Panama, 17 feet in Puget Sound and 27 feet at Prince Rupert, B. C., and making cargo cranes a necessity.

The question of whether handling machinery should be located on ship or on shore should not be determined by a comparison of the different classes of apparatus now in use, but rather by a comparison of the best of each class that can be constructed. As steam is the available power on ships and electric current on shore it becomes a question of steam winches on shipboard versus electric cranes and electric winches on the pier. If it is true that freight can be handled more economically in this country by the ship's winches than in European ports with cranes, the explanation may be found in the type of crane there used. The objections to the swinging crane, including the continued movement of heavy machinery and the long circular path of the load with the resulting sway, are too well understood to need more than a mention here. Cranes are now built that rack the load out and in on a straight line, avoiding the objections mentioned above and retaining the advantage of being operated by one man.

The Ship's Winch

The steam winch on shipboard usually requires three men, one on each line and one at the engine. Electric winches for use in the pier shed, as generally constructed, follow somewhat blindly the type of the steam winch requiring two men to handle the two lines, but there is no apparent reason why the two lines cannot be wound on drums driven by independent motors and operated by one man.

Cable ways have been suggested having one end anchored to a post on deck and the other attached to the freight shed where hoisting and conveying machinery would be located. This scheme seems to be open to the objection that the cable would be tightened and slackened by movements of the ship resulting from rough water and changes in load and tide, unless automatic means were provided for keeping a uniform tension. Electric loading and unloading machinery is now in the formative stage and in the early part of that stage. The same cannot be said of the steam winches mounted on the ship's deck. To consider the probable future of these two classes of machinery is by no means to indulge in idle speculation.

The practice of putting the cargo handling machinery on the ship came about, of course, by necessity, because of the large number of ports entirely unequipped. Will this necessity perpetuate itself? And if the necessity is not perpetuated, will the practice continue through sheer inertia?

If an engineer had free hands, unhampered by existing equipment and prejudice, it would seem the common-sense plan to place the handling machinery on shore, rather than load the ship down with deadweight, which serves no purpose during transit except to reduce its cargo-carrying and hence earning capacity.

It would be revolutionary to strip existing ships of their cargo winches and equip all piers where they land with handling machinery; but considering that some piers are now so equipped and must be for reasons mentioned above, it seems possible that the change may come about by degrees, the steam winches on ships gradually giving way to the more economically operated, more easily controlled and not less rapid electric cranes and winches on shore. Comparing the electric winch and the overhead cargo crane, the winch has the advantage of adaptability to existing sheds. The crane, while requiring a shed constructed to carry it and costing more per unit, has the advantage of economy of room, leaving the floor entirely unobstructed, and of being much more readily movable, reducing the number of units required.

Location of Freight Shed

In Hamburg, as in many other European ports, the freight sheds are set back sufficiently from the edge of the piers or quays to provide room for one or more railroad tracks, which are spanned by cranes. In our most important port, New York, peculiar conditions are found. As most of the piers on Manhattan Island are without railroad connections, no tracks are provided, and sheds are built within four to six feet of the sides of the pier. There are reasons to believe that this New York type has had an undue influence on other American ports where conditions are quite different.

There is not at the present time any accepted practice in this country in the location of tracks on piers. They are in some cases run through the center of the pier shed, in others outside of the shed along the side of the pier, and in some cases in both locations. Tracks through the center of the shed are usually depressed to bring the car floor approximately on a level with the shed floor, but there is no established practice in grade of tracks placed outside the shed. In our Pacific Coast ports may be found examples of the pier without railroad tracks alongside the shed, of the pier with one track, and of the pier with two tracks on each side. These outside tracks are in most cases flush with the pier deck, though in some cases depressed, and in some instances the track along one side of the pier is flush and that along the other side depressed.

This difference in practice in the location and grade of tracks is probably justified in some cases by different local conditions, but in many others it seems to reflect the engineer's opinion of the requirements of a business yet to be developed. There is not the same advantage of tracks along the side of our piers as there is in European ports, where open cars are used much more generally. Considering the fact that consignments are often badly mixed as they come from the ship's hold, making it necessary to sort the freight before it is loaded into cars, and that much of that to be reshipped by rail must go in box cars which cannot be served by cranes or winches, a comparatively small proportion of inbound miscellaneous cargo can be transferred directly from ship to cars. A larger proportion of outbound freight can be handled direct, as less sorting is required. The economy of direct handling is so great that it should be employed where possible.

Handling Freight Inside the Shed

Economical handling of freight inside the shed presents a difficult problem. For handling light package freight short distances, and particularly that which need not be

tiered for storage, nothing will probably ever supersede the hand truck, but for long distances some means that is much more rapid than the hand truck and requires less labor is needed. The storage battery truck and the overhead monorail system are competitors in this field. Progressing along the line of least resistance, the storage battery truck has been more frequently adopted. It can be more easily installed, as it will run in any old shed where a reasonably smooth floor is found, and it can be tried on a smaller scale. The overhead system requires a stronger building with more headroom and a more expensive initial installation. The advantage of greater speed, of economy of floor space and of being a hoisting as well as a conveying machine should count in its favor and find it a place in competition with the more easily installed and very useful battery truck.

In the development of freight-handling equipment, both for loading and discharging cargo and for distributing it in the shed and storage warehouse, it must for some time remain an open field between that which offers the easiest transition from our present crude methods and that which promises the best results in economy and speed—between the storage battery truck and the overhead track system—between the electric winch and the overhead wharf crane.

Points of Attack in the Terminal Problem

Possibilities for Reduction of Terminal Charges for Handling Freight—Faults to be Overcome in the Existing Conditions

BY JAMES A. JACKSON *

Perhaps there has never been a time in the history of the country when the maxim "In times of peace prepare for war" applies as forcibly to the freight handling business as at present. We are just recovering from a severe business depression, and if history repeats itself and the predictions of our masters of industry are fulfilled, we are on the verge of an era of prosperity which will make the good times of the past look dull and uninteresting. The Panama Canal has just opened and is stimulating both our coast-to-coast and foreign commerce in a remarkable way. The great European war has awakened our financiers and captains of industry to the great opportunity presented to build up an enormous South American trade; and it must be done rapidly, or the opportunity may be hopelessly lost. The war has also made our Government see daylight and stop playing politics on the merchant marine question, and laws either have been or will be made which will once more make it profitable for an American-owned vessel to sail under the Stars and Stripes. Thus no stretching of the imagination is necessary to predict a freight tonnage in the near future far ahead of anything we have ever seen.

Now the important question is: What will the freight bill amount to and how can it be reduced? At the present time we pay a transportation bill approximately three times our combined national, State and local taxes—truly an enormous amount. The freight carriers and handlers are interested from the standpoint of increasing profits, the manufacturers of machinery from the standpoint of obtaining new business, and the public from the standpoint of decreasing the high cost of living; therefore, a short analysis to show where the "high spots" in transportation costs exist and a few broad suggestions for reducing these "high spots" should be pertinent.

REDUCING TRANSPORTATION COSTS

James J. Hill, who is perhaps the country's leading authority on transportation questions, has said: "Its (the country's) prosperity as a whole and the welfare of every man in it, who engages in any gainful occupation, can escape threatened disaster only by such additions to, and enlargements of, existing facilities and terminals at our great central markets and our principal points of export as will relieve the congestion which now paralyzes traffic when any unusual demand is made upon them." How true this is can easily be seen when we find that by rail freight is hauled for three mills per ton mile and by water the cost is seven-tenths of a mill per ton mile, while the cost per ton for terminal handling by present methods varies from probably fifteen cents to seventy-five cents ((0/7½ to 3/1½), depending on the conditions and material handled. The average would probably be about thirty-five cents (1/5½) per ton. When it is considered that our railroads are handling something over a

Fig. 1.—Pier Showing Wasted Headroom. This Headroom Could be Utilized by Mechanical Stackers and Tierers

Fig. 2.—Handling Freight on a Storage Battery Industrial Truck. Load Shown Would Make 8 or 10 Hand Truck Loads

* Power and Mining Department, General Electric Company, Schenectady, N. Y.

Fig. 3.—Two Men, with Hand Truck, Handling Coffee in Nine-Bag Loads. There Were 81,000 bags in This Cargo. Compare This with the Conveyor Method

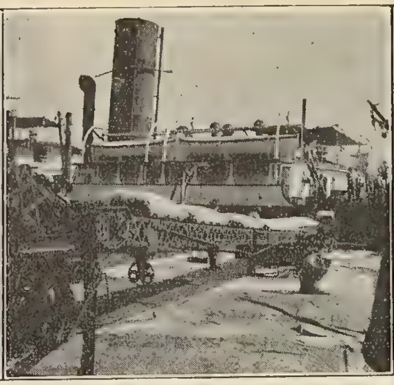


Fig. 4.—Unloading Coffee to Wharf Shed 100 Feet from Ship and Elevating Coffee in the Shed by Electrically-Driven, Portable Conveyor

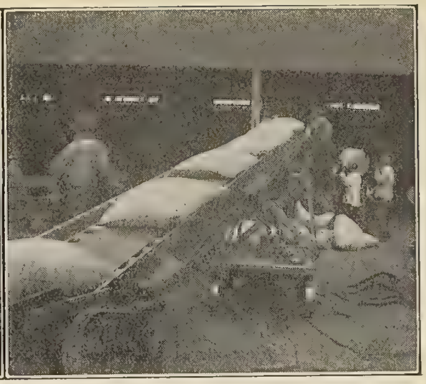


Fig. 5.—Portable Conveyor Carrying Coffee from Ship's Deck to Wharf Building at Rate of 1,800 Bags per Hour by Electrically-Driven Portable Conveyor

billion tons of miscellaneous freight per year (coal and ore excluded), it will be seen that a saving of only one cent (0/0½) per ton in terminal handling, assuming each ton to go through only one terminal, would save $10,000,000 (£2,050,000) annually. Assuming $5,000,000 (£1,025,000) of this to go to additional profits and reduced charges to the public and then capitalize the other $5,000,000 (£1,025,000) at 5 percent, making $100,000,000 (£$20,500,000) and we have some idea how much could reasonably be spent to save that one cent (0/0½) per ton at the terminals.

How to spend that $100,000,000 (£20,500,000) can be answered broadly in one word—"machinery." There is any quantity of machinery on the market to-day, eminently fitted for the work, provided it is intelligently selected and handled; and if a general demand for machinery is created, apparatus will be designed to fill the gaps which existing machinery cannot fill. This demand, then, must be created, and it must be done through an educational campaign which will be so forcible and so well "hammered in" that even the most obstinate will be convinced.

An Educational Campaign Imperative

Consulting engineers and dock and pier architects could exert a very valuable influence by laying out all new work with the idea of making it most adaptable to the use of machinery. This would soon result in some exceedingly efficient pier or terminal which could be pointed to as a convincing example of how to handle package freight. At present there is no such example in existence, while there are one or two failures due to recommendations being made without a thorough study of the subject.

Machinery and electrical apparatus manufacturers, where large enough to justify it, could develop specialists who could give their time to analyzing various freight terminal situations with a view of recommending machinery best adapted to meet the special conditions. It might be well at this point to add a word of caution—namely, that it would be bad business for a specialist to recommend his own machinery just to make a sale when his own judgment tells him it is not the very best apparatus for the place.

Large central stations supplying electric power can assist in this educational work to their advantage by training their power solicitors to go after this dock, pier and terminal business in an intelligent way. Many solicitors, no doubt, do not realize the opportunity to get business because they are not sufficiently familiar with the conditions to know any arguments whereby the power they have to sell can be used to reduce costs and conserve floor space. Electricity is, without doubt, the most desirable power to use on account of its flexibility and the large electrical manufacturers will be glad to co-operate with the central station in securing this business. In

Fig. 6.—Four Mules Drawing 14 Bales of Cotton Three Miles per Hour. Compare This with Battery Truck Crane Towing 4 Tons of Coffee at 4 Miles per Hour over Reasonably Smooth Pavement

Fig. 7.—Battery Truck Crane Towing 50 Bags of Coffee from Wharf Building to Warehouse. The Rope Slings Are for Hoisting the Bags to Upper Floors

many places storage battery trucks and truck cranes can be used very efficiently, and this is a most desirable form of load for central stations, as arrangements can usually be made to charge the batteries during light load periods, thus improving the load factor.

The terminal and pier owners will not only have to educate themselves to see the advantage of installing machinery, but will then have to educate the roustabout freight handler to use the machinery efficiently. An official of a large municipal dock, and a strong advocate for the use of machinery, recently said that you could supply two stevedoring companies with the same machinery to do the same work and one company would break even or possibly clear 10 percent over old hand methods, while the other company would clean up 200 percent profits. As this official spoke from experience, it shows what must still be accomplished after machinery is installed.

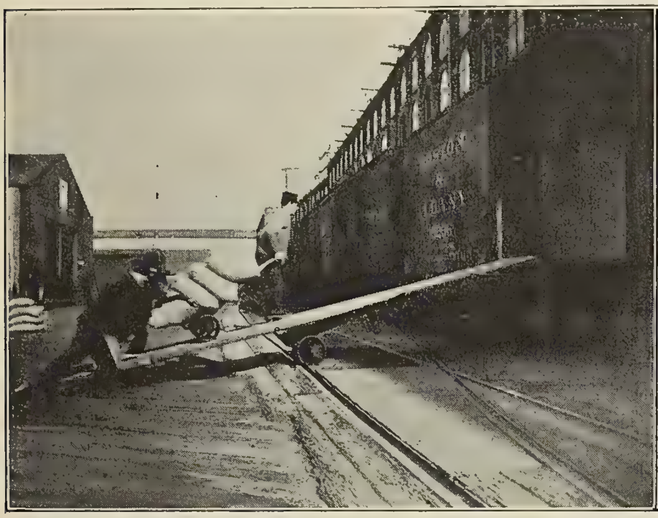


Fig. 8.—Loading a Freight Car by Hand Under the Brooklyn Bridge. Compare This with Battery-Truck-Crane Method

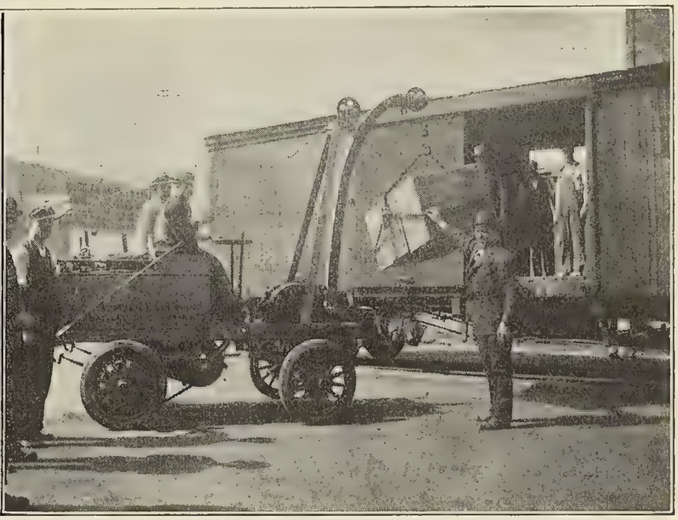


Fig. 9.—Loading Box Car with Storage Battery Truck Crane. Handling Three 300-pound Boxes per Minute from 75 Feet Away from Car Door

POSSIBILITIES FOR REDUCTION OF TERMINAL CHARGES

In addition to education, a list of subjects, with short comments, is given below, all of which offer big possibilities for the reduction of terminal charges for handling freight.

1. The design of new piers, terminals and warehouses, especially adapted to the use of machinery. Close co-operation between consulting engineers, architects and machinery manufacturers should do much to accomplish results along this line.

2. The redesign of existing piers, terminals, warehouses, etc., to adapt them to the use of machinery.

3. The possibility of using wet docks where tidal conditions are bad. This would overcome all variation in the vessel's height except that caused by the change in load. If the dock was made to accommodate a single vessel, large low-head pumps might be employed to hold the vessel stationary, regardless of load, by varying the height of water in the dock. This stability might permit the use of some form of conveying apparatus which would so lessen the time and cost of unloading that the expense of the wet dock and pumps would be justified.

4. Installation of mechanical devices in existing buildings with no change in the design of the building. This is one of the most important fields there is to work in and at the same time one of the hardest in which to accomplish the best results.

5. Replacing existing mechanical apparatus with improved and more efficient apparatus. For instance, electrically driven apparatus could be substituted for slow and inefficient steam, hydraulic and animal-operated apparatus in many places to advantage—also electric trucks could be advantageously used instead of hand trucks.

6. The addition of new machinery to work along with old to improve the plant efficiency as a whole. An instance is in the writer's mind where the addition of a chain sling at a cost of about $2 (8/4) just doubled the efficiency at which $3,500 (£718) worth of apparatus was being worked.

7. The design of vessels, barges, lighters, etc., to make them more adaptable to the use of rapid freight handling devices.

8. The modification of existing vessels, lighters, barges, etc., to make them more adaptable to the use of rapid freight handling machinery.

9. The design of special freight cars for miscellaneous package freight. It appears that the present box cars are seldom loaded to their capacity, which means that they are inefficiently operated. It seems that a much lighter and perhaps smaller car with a removable top as well as side doors could be used far more efficiently.

10. The consolidation of railroad and steamship terminals, together with warehouses and manufacturing concerns, at common points. This is more a question of financing and could probably be best handled by development companies.

11. Devising a more rapid system for handling freight cars in freight yards. An enormous amount of time is now lost between the time a car arrives at the edge of a city until it is spotted for unloading, and both time and money could be saved by improving this situation.

12. The standardization of the size, shape and weight of packages. Anything accomplished along this line would make the use of machinery far more simple.

13. The study of foreign methods of freight handling.

No doubt, many more suggestions could be made, but the above seem to offer the largest possibilities.

AMERICAN REGISTRY OF FOREIGN-BUILT VESSELS.—Up to and including February 20, a total of 129 foreign-built vessels, aggregating 468,509 gross tons, had been given American registry.

Barge Canal Terminal

Proper terminal facilities at Rome, N. Y., on the new State $100,000,000 (£20,500,000) barge canal system demanded the construction of 900 feet of dock parallel to, and only a short distance from, the canal channel. The method of construction adopted for this dock consisted of an anchored bulkhead wall made of Lackawanna steel sheet piling capped with reinforced concrete and tied to a continuous line of wooden piles driven 40 feet back of and parallel to the bulkhead, as shown in Fig. 1. A trench was excavated and the bulkhead of steel sheet piling wall was that of M. A. Talbot & Co., amounting to $91,594 (£18,870).

The wall has now been satisfactorily completed, as shown in Fig. 3. Fig. 2 shows the wall of Lackawanna, 14-inch by 3/8-inch arched web steel sheet piling driven in 26-foot lengths. Also the system of reinforcing rods used to hold the protecting concrete on the top 8 feet of the wall is shown in the photograph. The material to be taken out by hydraulic dredging is shown on the left of the sheet piling wall. The bulkhead wall was entirely completed before any dredging was done.

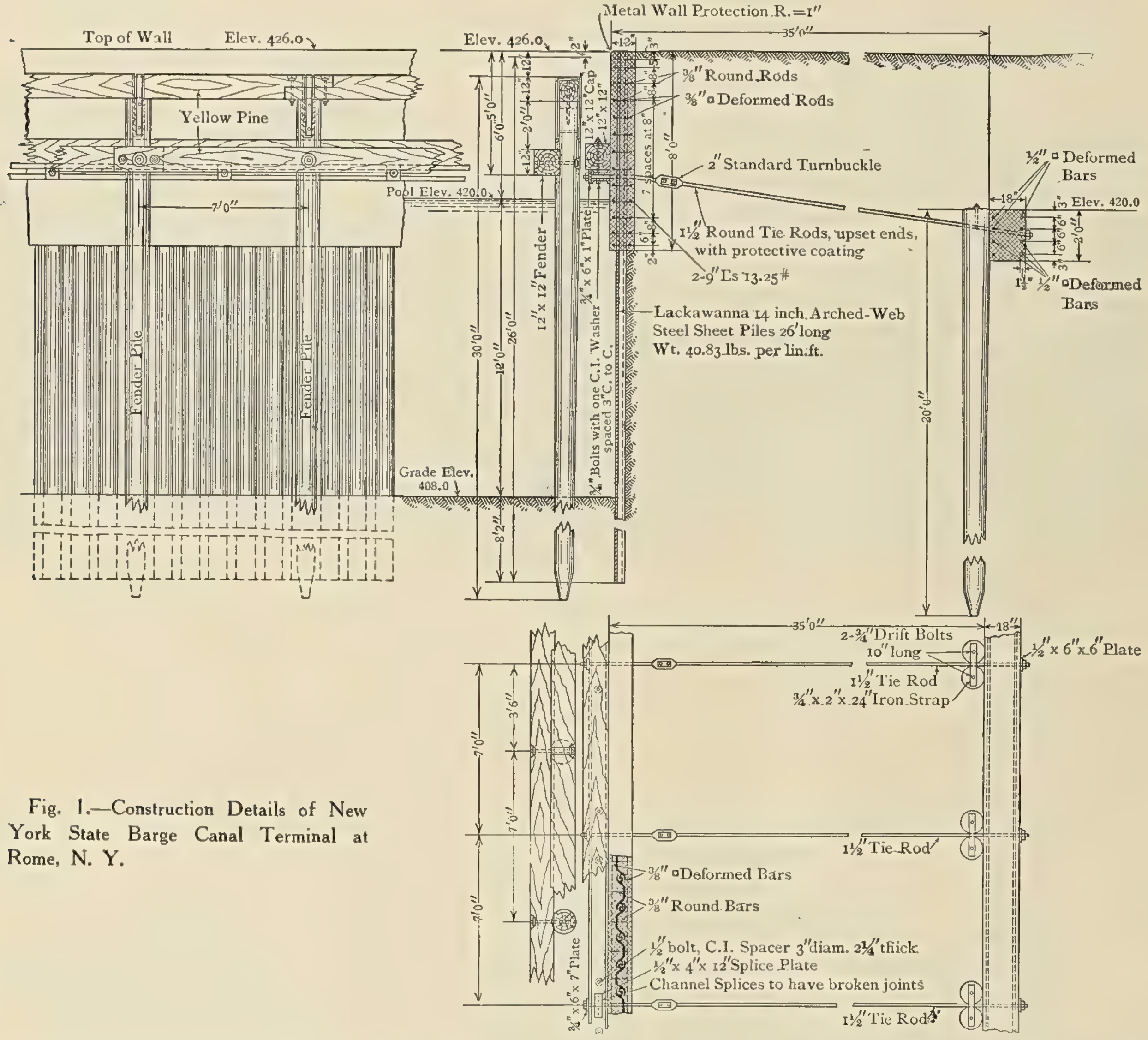


Fig. 1.—Construction Details of New York State Barge Canal Terminal at Rome, N. Y.

ing driven to a point several feet below the canal grade. The top 8 feet of this steel sheet piling was incased within a narrow wall of concrete, while large steel tie rods, spaced 6 feet apart lengthwise of the walls, anchored the bulkhead to the line of wooden piles back of the wall.

It was figured that the use of steel sheet piling in this way would involve considerably lower costs than in the construction of a mass concrete gravity wall in deep excavation where a greater quantity of sheet piling would be required for cofferdams and where the expense of maintaining such cofferdams dry during construction would add a large item to the cost of construction. The lowest bid submitted for the concrete top steel sheet

Fig. 3 shows the dock completed with the exception of making the final grade. It will be noted that the Lackawanna steel sheet piling, when driven, has been formed to a true line throughout its length, so that by making the foundation concrete reinforcement 14 inches thick overall, the entire length of the dock face, 900 feet, was in an absolutely straight line on both the front and back sides of the wall. No protection of the steel piling against corrosion, other than the concrete on the top 8 feet, was considered necessary.

The construction of this dock was supervised throughout by J. A. O'Connor, terminal engineer, and Guy L. Noble, division engineer in charge, department of engineer and surveyor, New York city.

Facilities for Shipping and Freight Handling at River Ports*

BY E. E. R. TRATMAN †

Success in the development of inland navigation depends in large measure upon the efficient, economical and prompt handling of shipments at the river ports. The cost of carrying freight between ports is small, but the cost of handling freight at the terminal points is a large item in the total cost of transportation. And it must be remembered that difficulties, delays, expenses, damages and losses to freight at these points will soon tend to discourage shippers.

The facilities to be provided include suitable accommodation for vessels (whether steamboats or barges) and suitable means for handling the freight. They must be adapted, of course, to the local conditions in each case. These facilities may be classed as follows:

1. A water-front channel of proper depth, width and location. This is a matter for the joint consideration of the local authorities and their engineers, and the War Department or U. S. engineers.

2. Boat landings, with levees, wharves, piers, water-front freight sheds, warehouses, etc.

3. Mechanical equipment for handling freight to and from the boats. This includes fixed or traveling cranes, hoists, portable conveyors for freight or freight trucks, small motor freight trucks, etc., the equipment varying, of course, with topographical and traffic conditions at each point.

4. Rail connections between the river front and the railway lines entering the city or town. Many ports may have a considerable amount of transfer or rail-and-water freight, and for the economical handling of this it will be very desirable to transfer freight directly between boats and cars.

Fig.2.—Steel Sheet Piling Bulkhead Wall Under Construction, Showing Reinforcement for Concrete Cap

Fig. 3.—Completed Wall Before Dredging and Grading

River Freight Traffic

A very desirable line of inquiry is in regard to the present and prospective traffic at various river ports. That is, the amount and character of the freight. Estimates have been made at various times, but many of these are somewhat rose-colored and based largely on guesses in which hope is the father of the figures presented.

But for the cold, calm business proposition of operating river traffic to advantage it is very desirable that there should be some reliable and reasonable statement as to the character and amount of traffic to be handled.

This applies not only to the general proposition of developing river traffic, but also to the determination of the character and cost of the facilities to be provided in each individual case.

Municipal Steamboat Landing at Peoria, Ill.—The steamboat landing at Peoria, Ill., on the Illinois River, was originally a bulkhead wall for the landing of freight to and from the boats, but was inconvenient owing to the varying stages of the water level. The city decided to improve conditions by removing this bulkhead for a length of 1,350 feet and building a heavy paved bank or levee from which gangways could be laid to the steamboats at any stage of the water. At present this has been built for about 850 feet, with a retaining wall at the end to support the bank.

*From an address at the River Terminal Conference at St. Louis, February 18-19.

†Western Editor of *Engineering News*.

Freight Handling at Havana, Cuba

New Reinforced-Concrete Steamship Piers at Havana Equipped with Efficient Means for Handling Freight

The Port of Havana Docks Company has recently completed the erection, in Havana, Cuba, of two reinforced concrete piers, called the San Francisco and the Machina piers, each two stories high, 164 feet wide, and 660 and 680 feet long, respectively. The two structures are connected by a four-story head house, located opposite the Custom House. The bulkhead building is 740 feet long, 66 feet wide, four stories high in the center portion, three stories high at each end, with a central tower 105 feet high. The entire structure is supported on 4,000 concrete piles and the water depth about the piers is from 12 to 40 feet.

Fig. 1.—Bulkhead Building at Head of New Havana Steamship Piers

The design of these piers was undertaken by Barclay, Parsons & Klapp, consulting engineers of New York, and the general contractor was MacArthur, Perks & Co., Ltd., of Ottawa and New York. The concrete construction follows the very latest practice and includes some interesting features, to which considerable attention was given in the engineering press.

The general arrangement and equipment provide for handling an immense amount of freight with the greatest possible dispatch and efficiency. Practically all freight that comes into Havana is unloaded at these piers, whereas formerly it was lightered at excessive cost to and from the vessels anchored in the harbor. The equipment of the buildings, for handling all this freight, was given very careful attention by the engineers; this was especially necessary, as the boats unload at the first floor level and a very large part of this freight is shipped out from the second floor level. It was at first planned to use a number of platform elevators, but this would have caused a considerable waste of time with the men going up with the trucks and returning empty; the idea was therefore abandoned and two freight escalators were worked into the design, one of which is shown in Fig. 5.

The two escalators, designed and manufactured by the Stephens-Adamson Manufacturing Company, Aurora, Ill., are identical in construction and size, each being 48 inches wide by 55 feet long. Both upper and lower ends are curved flush with the floors and the main portion of each is inclined about 28 degrees. The construction consists of two strands of heavy steel bar roller chain, 6 inches pitch, running on steel angles and carrying 3-inch maple flights closely spaced. The escalators deliver the boxes and packages on the second floor. Above this floor is a 20-ton traveling crane of 30-foot span, and directly below the crane is a depressed trough containing two standard gage tracks, which connect with the elevated railroad of the city. This arrangement allows for unloading freight directly from ships to cars, or vice versa, without extra handling. As compared with the former methods in vogue in this port, when all of the freight was lightered to and from the ships anchored in the harbor, at a cost of about \$2 (8/4) per ton, the saving in the cost of

Fig. 2.—View of New Havana Piers during Construction, Showing One Pier Completed and a Portion of the Other Ready for the Superstructure

Fig. 3.—Upper Story of Pier Shed, Showing Ample Lighting and Location of Depressed Tracks for Connection to the City's Elevated Railroad System

Fig. 4.—Lower Story of Pier Shed, Showing Type of Reinforced Concrete Construction

handling freight is apparent, to say nothing of the elimination of the confusion and congestion that formerly prevailed at the old piers.

TERMINAL IMPROVEMENTS AT OAKLAND, CAL.—From $16,000,000 to $20,000,000 is being expended by the railroads at Oakland, Cal., on terminal improvements to provide facilities for handling about 2,500,000 tons of freight annually. In addition, municipal wharves have been built by the city giving about 3,500 feet of berthing space, at which it is expected about 500,000 tons of additional maritime commerce will be handled during the year.

Fig. 5.—Escalator Running from First to Second Story of Havana Pier

Barges Equipped with Brownhoist Locomotive Cranes for Handling Coal

The Dominion Coal Company, at Montreal, Quebec, has two barges of 1,000 tons carrying capacity each, fitted with Brownhoist locomotive cranes with grab buckets, as shown in Fig. 1. The barges have open hatches 16 feet wide, extending practically from stem to stern. The frames of the cranes have a gage of 16 feet and run on a track of the same gage, so that they can be moved to any part of the barge and unload the coal with a minimum of trimming.

The booms of the cranes are 50 feet long, which enables the bunkering of the largest transatlantic steamers. The cranes are also equally effective for bunkering

Fig. 1.—Dominion Coal Company's Coal Barge, Fitted with Steam Locomotive Crane

through side ports, a hopper being inserted into the port holes so that the coal is fed directly into the bunkers. The barges can also be used for delivering coal to manufacturing plants situated on the canals or on the waterfront.

Another similar application of a 15-ton Brownhoist locomotive crane with a 54 cubic foot grab bucket is used by the Astoria Light, Heat & Power Company, Astoria, Long Island.

Inclined Elevators Increase Economy of Marine Terminals

As most of the package freight on American coastwise vessels is loaded and discharged by trucks through side ports, the variations of tide and of the draft of the vessel while at the pier necessitate handling the trucks up and down inclines of varying grades. Obviously, as the grade increases, more men are required to push a given load up the incline and the time required for the operation is increased. To overcome this difficulty and to reduce both the time and cost of handling freight at the terminals, the Otis Elevator Company of New York has developed a continuously running inclined electric elevator capable of drawing ordinary trucks with loads up to 1,000 pounds up an inclined gangway at speeds of 125 to 250 feet per minute. The cost of power for operating the elevator is about one-tenth of a cent per ton and reports from users show savings of 13 to 15 percent in the cost of handling freight and a reduction of 15 to 20 percent in the time required for discharging a vessel.

The inclined elevator consists of an endless chain which runs in a lubricated steel channel, and is provided with special projections which engage with the axles of the trucks. It will be seen from the illustrations, which show one of four inclined elevators installed at Pier 5 of the New York Central & Hudson River Railroad at Weehawken, N. J., that the chain is driven by a sprocket wheel whose shaft is connected through reduction gear-

Fig. 1.—Otis Inclined Elevator in Operation at Pier 5 of the New York Central & Hudson River Railroad at Weehawken, N. J.

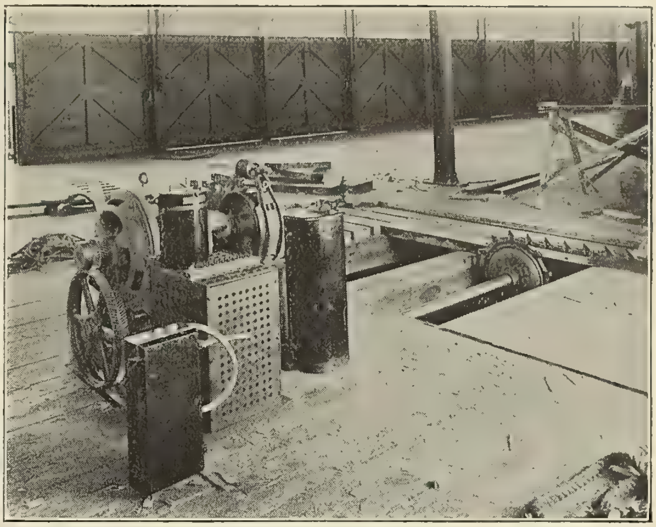


Fig. 2.—Motor, Controller and Reduction Gearing of Otis Inclined Elevator

ing to an electric motor on the pier floor. The motor is of the alternating current type, wound for two speeds, driving the hauling chain at speeds of 125 to 250 feet per minute. The object of the two speeds is to permit slowing up the elevator to handle unusually heavy loads. On the outer end of the motor shaft is a brake pulley and an electric brake equipment which stops the elevator whenever the current is shut off. This feature is of importance, as it is now the practice to load the trucks to their full capacity, with the result that occasionally one of the packages falls off, and it is important to stop the elevator and hold it securely with the line of trucks still engaging the chain while the package is replaced on the truck.

At the Union Wharf of the Eastern Steamship Company in Boston, where three of these elevators are installed, a saving of fully 20 percent in the time required for unloading the vessels is made. The elevators are operated only when, on account of tidal and draft conditions, the gangways are at an inclination, and it is estimated that the three machines carry 125 tons of freight per hour during a period of five hours each day at a cost for power of one-sixth of a cent per ton, reducing the time of discharging the vessels from 15 to 20 percent. At another installation it has been authoritatively stated that the inclined elevators have saved 9 cents (0/4½) in the transfer of every ton of freight handled, the cost of power in this case being only one-tenth of a cent per ton.

The Merchants & Miners Transportation Company, which has two of these machines at its Savannah terminal, four at its Mystic Wharf terminal in Boston, and six at its new city terminal in South Boston, estimates savings of 13 to 15 percent in the cost of handling freight by the inclined elevators, while at the Weehawken piers of the New York Central & Hudson River Railroad the labor cost is reduced from 2 to 3 cents (0/1 to 0/1½) per ton, and the time for unloading is decreased so that the capacity of the marine equipment is increased from 20 to 40 percent, depending upon conditions. Also at both the New York and Norfolk terminals of the Old Dominion Steamship Company, inclined elevators have saved the labor of about four longshoremen for periods of about five hours per day. Similar savings have been effected by the installation of inclined elevators at other marine terminals, and they have also been of great benefit in conveying hand trucks from the first to the second story of pier sheds and warehouses.

Fig. 1.—General View of Shipyard at Grand Trunk Terminal, Prince Rupert, B. C.

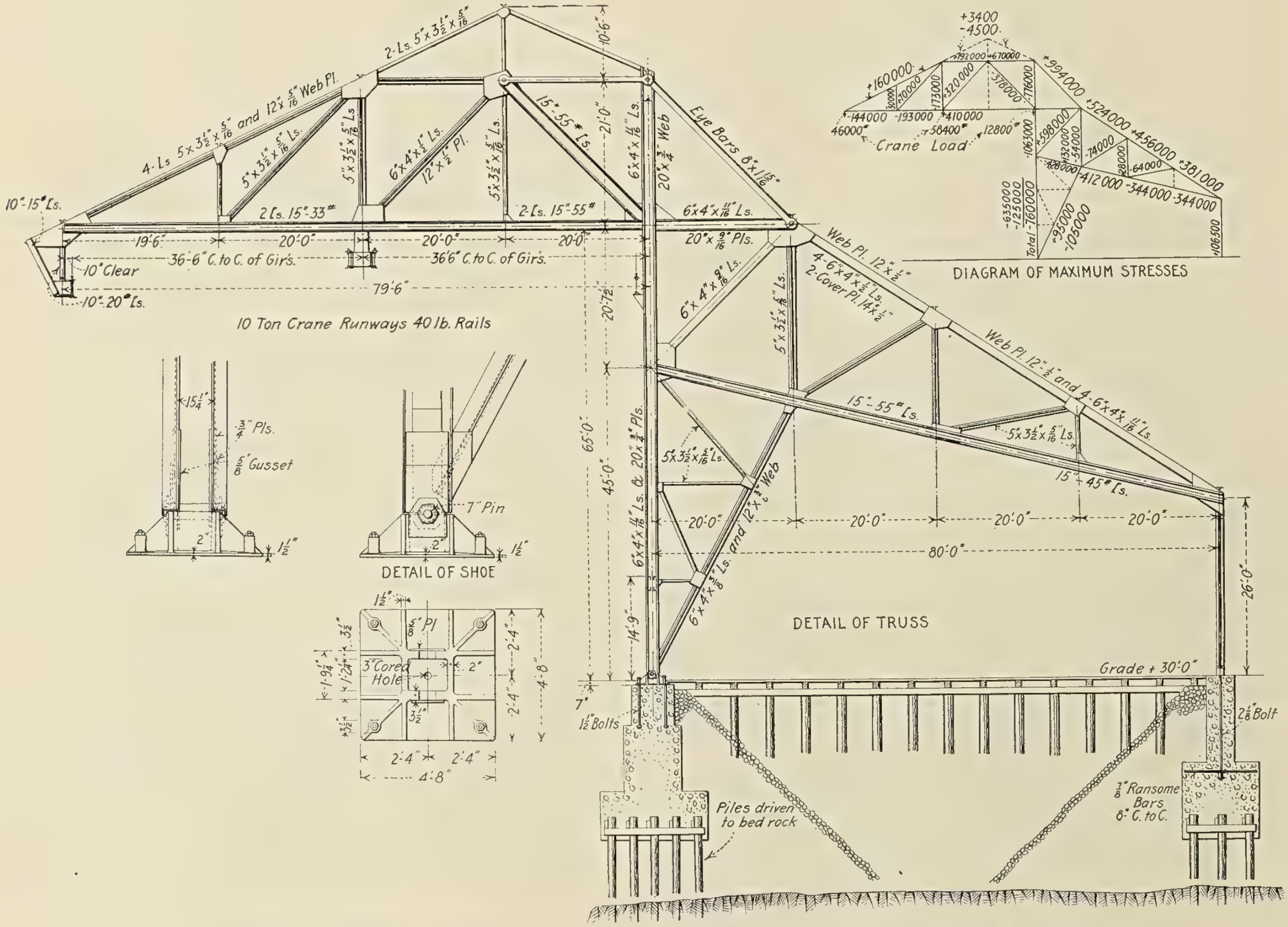


Fig. 2.—Structural Framing of Shipbuilding Shed, with Sketch Showing Maximum Stresses on Structural Members

Shipyard at Prince Rupert Terminal

Unusual Structure Erected in Connection with Drydock and Repair Plant at Prince Rupert, B. C., for the Grand Trunk Railroad

BY WILLIAM T. DONNELLY *

While the climate at Prince Rupert is mild to such a degree that it is possible to do outdoor work all the year round, there is so much rain that it is most desirable to work under cover, and the building illustrated has been designed and constructed to meet these conditions.

The building is 300 feet long by 160 feet wide. The entire weight of the structure is carried on the center line of foundations. One-half of the roof is carried as an overhang, and besides supporting its own weight carries two 10-ton overhead traveling cranes. It will be noticed that at one end of the building there is a steel lattice work constructed to carry these cranes beyond the building proper for the purpose of taking material direct from the cars or from the wharf and placing it upon the work under construction.

The flooring under the overhanging portion is carried on very heavy piling, as will be seen by reference to Fig. 3. The outer 40 feet slopes $2\frac{1}{4}$ inches to the foot and serves as launching ways for side launching of vessels. When completed there is a clear height under the

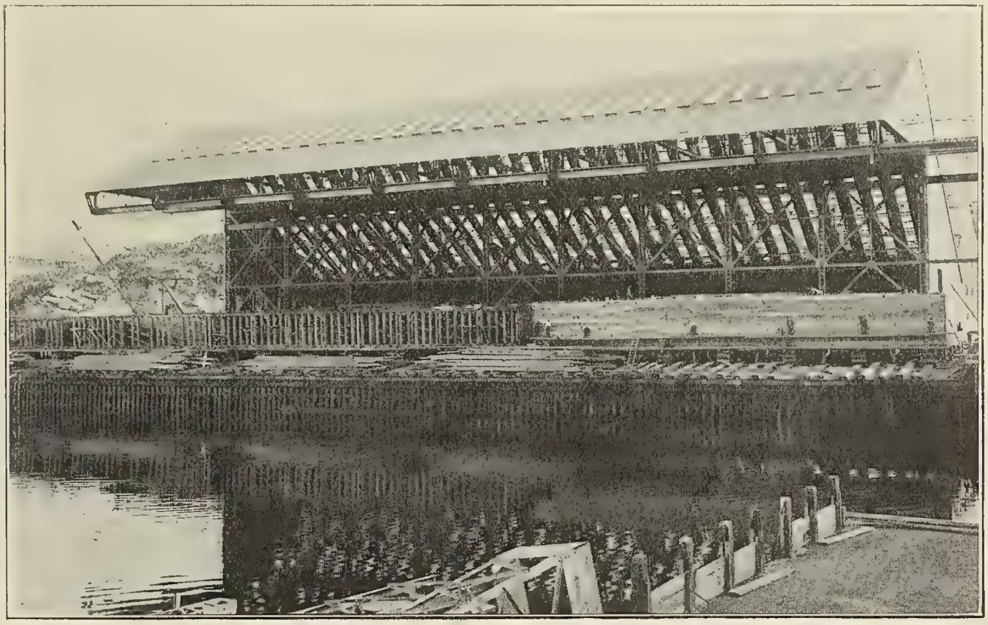


Fig. 3.—Covered Shipbuilding Berth Arranged for Side Launching of Vessels

* Consulting Engineer, 17 Battery Place, New York.

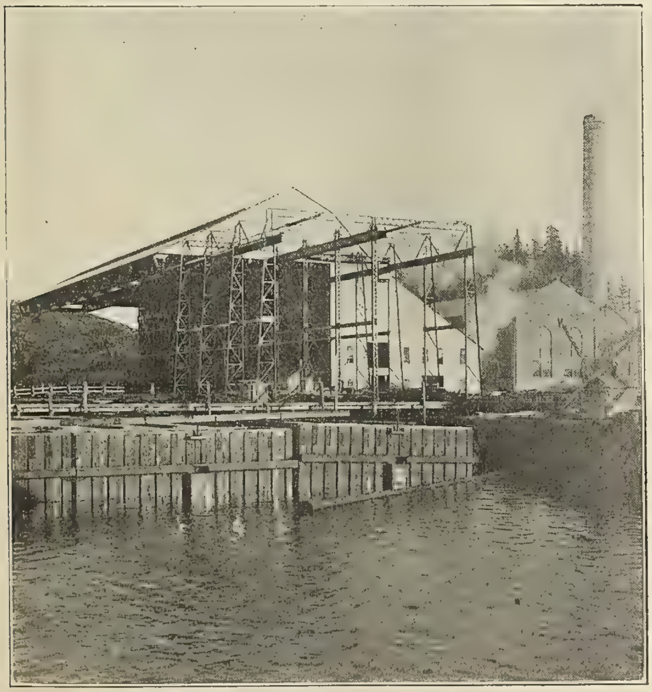


Fig. 4.—End View of Shipbuilding Shed

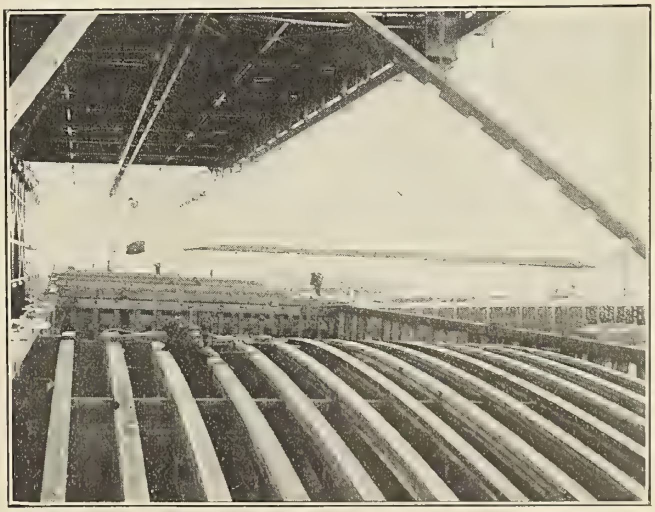


Fig. 5.—View in Shed. Dock Pontoons Under Construction

overhead cranes of 65 feet and a clear length under cover of 300 feet, made up of nine spans 33 feet 4 inches on centers. This building was primarily designed and is now being used for the building of twelve pontoons for the 20,000-ton floating drydock, which will form an important part of this repair yard. Six of these pontoons have been completed and launched and three more are now being constructed under the shed.

The covered-in portion of the building in the rear of the building berth is used for wook-working tools and is equipped with the very latest and most up-to-date woodworking machinery. An upper floor over this portion is 300 feet long by 80 feet wide in the clear, without supports, giving a very fine floor for laying out ships.

By reference to Fig. 2, it will be seen that the center line of the columns on 33 feet 4 inch centers are carried on concrete foundations, some of which go to rock while others are carried on piles. To guard against the possible yielding of any single foundation, a vertical truss was worked in, connecting these columns, of sufficient strength to distribute the weight from any single foundation to the two adjoining. Very heavy wind bracing was introduced to resist unusually severe weather conditions. The weight of the overhanging portion with the addition of the load made it necessary to provide heavy concrete bases for the rear columns, or, in other words, under extreme conditions more than the total weight of the building is carried on the center foundations.

While side launching as provided for by this construction is unusual on the Pacific Coast, it is the rule on the Great Lakes and has been introduced at Los Angeles by a shipbuilder coming from the Great Lakes. The design of this building originated with Mr. Frank E. Kirby, well known in shipping on the Great Lakes.

Some of the photographs show how the building is now being utilized for building pontoons, and it has now been in use a sufficient time to fully test and demonstrate the utility and practicability of the general plan. At the present time there are being used on three pontoons building under this shed 28 air tools. These are used for boring, driving of spike and rods and for calking finished pontoons. Compressed air is furnished from a steam-driven air compressor with a capacity of 1,500 cubic feet of free air per minute at a pressure of 100 pounds. This machine, besides furnishing air for building the pontoons, is also driving riveters for the steel erection of the wings of the first section of the floating drydock and for tank work on adjoining property of the Imperial Oil Company.

The twelve pontoons which are to provide the lifting power for the 20,000-ton dock will contain 4,000,000 feet of lumber, and with the tool facilities and advantages of the overhead traveling crane it is possible to launch one of these pontoons every month.

Fig. 1.—Coaling the *Imperator* with De Mayo Elevators; 8,200 Tons of Coal Placed in the Bunkers in 19 Hours

The De Mayo System for Coaling Ships

The present tendency toward greater bunker capacities in ocean liners, and shorter periods in port, has created the necessity for an apparatus which will reduce the time required for coaling vessels and which will require less space, cut down the labor and maintenance costs and eliminate the nuisance of flying coal dirt. When this need was first felt, some ten years ago, a portable elevator was developed, which, when suspended from a swinging boom at the side of a steamship and operated by electricity, was capable of discharging from a barge alongside 75 to 100 tons of coal per hour directly into the bunkers of the ship. By using a number of these machines on each side of the vessel it has now become possible to fill the bunkers of a modern leviathan like the *Imperator* with 8,200 tons of coal in the short space of only nineteen hours.

The machine that has made such a performance possible is known as the De Mayo portable elevator, and has been placed on the market by the Hudson Machinery

Fig. 2.—Transferring Cargo of Coal from Collier to Railway Cars with De Mayo Elevators

Company, New York. It consists of a steel frame, housed in to prevent the flying of coal dust, at the top and bottom of which are steel drums over which an endless belt of steel buckets is driven by an electric motor installed in the head of the elevator. The machine digs into the coal automatically under its own weight, and as the coal is carried up to the top of the elevator by the endless belt of buckets it is discharged into a telescopic chute through which it is conveyed by gravity directly to the ship's coaling ports.

The construction of the machine is simple. Its fundamental feature consists of the elimination of all chains. The steel bucket plates and the steel spacer plates that separate them are hinged together by steel pins, thus forming an endless belt which enables the machine to dig in heavy material without danger of breakdowns. The machines are entirely self-contained and may be suspended from a cable attached to a swinging boom. On the smaller sizes a power-driven winch is attached to the frame of the elevator which raises and lowers the machine. An attendant is required only to swing the machine about and to aid in "cleaning up."

The illustrations show some of the applications of this machine to the coaling of ships in New York harbor. In the case of the *Imperator* (Fig. 1), when in service this vessel lies in port but two days, of which only twenty-four

Fig. 3.—Tandem Arrangement of De Mayo Elevators Used in Coaling the *Cincinnati*

Fig. 4.—Coaling the American Liner *New York* at Pier 62, North River

hours are available for bunkering approximately 8,200 tons of coal. With the De Mayo system this work has been done in nineteen hours.

In Fig. 3 is shown an unusual arrangement, necessitated in coaling the Hamburg-American liner *Cincinnati*. In order to reach the forward deck hatch two machines were coupled together, tandem fashion, bridging the exceptional height in two steps. A boot was constructed for the upper elevator, into which the lower elevator discharged the coal. Two machines working in the barge were used to feed the upper machine, thus showing the overload capacity of this type of machine.

Aside from its usefulness in coaling ships, this machine is equally applicable for use in unloading stone, crushed rock, sand, gravel, grain or any bulk material from cars, drays or other conveyances, as well as from barges, steam vessels and other craft. Its capacity, portability and low operating costs make it an important accessory to terminal facilities. The power required varies from 5 horsepower in the smaller unloaders to 10 horsepower in the 75-ton-capacity elevators.

Economy Gained by Handling Freight with Electric Trucks at Marine Terminals

At one of the steamship piers on the New York waterfront, where a number of electric trucks manufactured by the Elwell-Parker Electric Company, Cleveland, Ohio, have been installed to increase the economy of handling freight, observations covering a period of thirty days have shown that the cost of handling freight by electric trucks, including all items, such as labor, power, maintenance, insurance, amortization, etc., amounted to only 10.41 cents (0/5¼) per ton, as against 25 cents (1/0½) per ton for hand trucking.

The items of cost were as follows:

Labor	$0.087
Power	0.0039
Maintenance	0.0033
Investment, depreciation, etc.	0.0099
Total	$0.1041

In another case, at the Lehigh Valley terminal at Buffalo, N. Y., the following results were obtained:

Total trucks in service	38
Cost, including maintenance and supplies, vessels to cars	0.1923
Hand trucks (various commodities)	0.3100
Electric trucks—from cars to vessels	0.2115
Hand trucks—from cars to vessels	0.3100
Electric trucks—from platforms to cars	0.1138
Hand trucks—from platforms to cars	0.1600

Other reductions can be made in this latter item when operations are not interfered with by congestion due to car shortages.

Trucks have been used in every branch of the work, and with the exception of handling heavy structural iron, such as long beams, etc., from the floor of the house to the vessel, they are far superior to hand-truck operation. Their use in handling this long material from the floor to the vessel is restricted by reason of the construction of the vessel.

A substantial increase in the efficiency of the electric trucks can be obtained by increasing the sling loads from the steamer, or proper assembling of sling loads in the hold of the vessel would greatly enhance the capacity of the electric truck operation by permitting proper draft from the vessel to the car or distributing point on the floor.

Electric trucks have shown a decided economy in the operation at this plant and a largely increased facility by reason of more freeway. Other economies are possible by direct unloading during certain periods of lake navigation, from cars to vessel, instead of double-handed from cars to floor and floor to vessel. Further, no difficulty was experienced in the operation of the trucks by the laborers, as they were eager to act as operators and required but little instruction to become efficient in this work. As a matter of fact, both the employee and the employer can benefit materially by the adoption of electric trucks, as with the old method of hand trucking the men are paid at a flat daily rate, whereas by using the electric truck and working on a tonnage basis the employee is able to increase his compensation in some cases by as much as 20 percent.

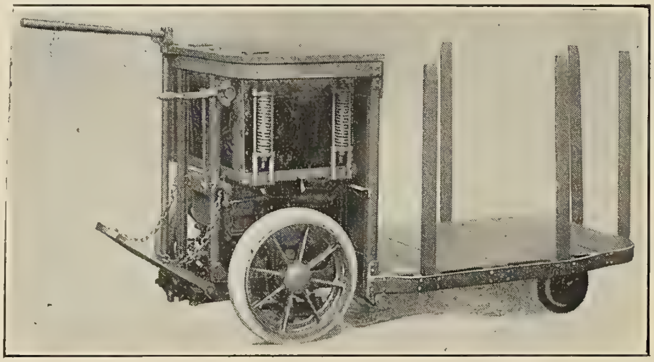


Fig. 1.—Elwell-Parker Freight Truck

Elwell-Parker Truck

The electric freight truck (Fig. 1), manufactured by the Elwell-Parker Electric Company, Cleveland, Ohio, is of peculiar design, which enables it to enter narrow spaces and to be handled with ease on a platform or in a warehouse. As the platform of the truck is very low to the ground it is particularly well suited for the handling of heavy freight in small bulk. The truck weighs 1,900 pounds and has a capacity of 4,000 pounds. The wheel base is 53 inches and the turning radius 6½ feet. Some of its distinguishing features are automatic control, automatic brakes and the four-wheel steer.

The operator stands upright on a small platform, operating the steering lever with his right hand and the controller handle with his left hand. The operating platform is divided into two halves. The left half, or switch platform, is located on the same side as the controller handle and operates the automatic switch or circuit breaker, which is closed as long as the operator stands on the platform, but which automatically opens when the operator steps off the platform. The right half, or brake platform, which is controlled by the operator's right foot, automatically applies the brakes when his foot is raised or when he jumps off the truck. In this way accidents and emergencies are provided against, as by jumping off the truck the operator automatically shuts off the power and applies the brakes, bringing the machine to a stop almost instantly.

The two sets of wheels are so arranged that both the rear and the front wheels automatically take the same radius of curve and all four wheels are controlled by the one steering lever. This feature permits operation in narrow aisle spaces and under congested conditions, reducing the space required for turning to a minimum.

The motor is mounted under the platform and is direct-connected to a worm gear and the power is transmitted through a differential to the hubs of the two rear wheels by utilizing a special universal connection. Either lead or Edison-type batteries may be used. On account of its low platform the type of truck shown in Fig. 1 is particularly adapted for loading heavy packages, such as barrels of oil, sugar, etc.

Application of Electric Trucks at Terminals

Figs. 2 and 3 show how one drop-frame electric truck with one man does the work of ten hand trucks and ten men. These views were taken while the trucks were handling cotton for the Central of Georgia railroad at Savannah, Ga. Throughout the South at the great ports where such trucks are used the cost of handling cotton is being lowered anywhere from 50 to 75 percent, depending upon the distance of haul, loading facilities and like conditions.

Figs. 2 and 3.—One Man with Electric Truck Replaces Ten Men with Ten Hand Trucks

Fig. 4 shows a special type of tractor carrying various miscellaneous loads in trailers. In a great many cases the trucks and trailers are designed for some particular work because of the varying conditions of operation. In narrow, restricted passages with sharp turns, it is usual to have all four wheels actuated by the steering mechanism. In the case shown in Fig. 4 the tractor replaces twenty-one men.

At the Savannah terminal of the Ocean Steamship Company, where electric trucks are employed for loading cotton, and the round trip from the point of loading to the vessel amounted to 2,500 feet, it was found that one man with a hand truck made the round trip in 24 minutes, while an electric truck, replacing ten men and ten hand trucks, made the round trip in 9 minutes, thus showing the possibilities in saving time and thereby increasing the all-around efficiency and economy.

Fig. 5 is a view taken at Port McNicoll, Ontario, Canada, on the Canadian Pacific. The truck shown carries 52 sacks of export flour, as compared with 5 sacks on hand trucks. In loading trucks direct from the hatch of a vessel it has been necessary to increase the capacity of the sling to lift one truck load of sacks from the hold onto the truck in one operation, thus facilitating quicker loading and unloading.

While the foregoing are only a few of the many instances that might be cited to show the savings in time and money that are possible in handling freight by electric trucks in place of hand trucks, nevertheless they are sufficient to show the possibilities that can be realized by introducing such methods at marine terminals.

The immense increase in the volume of freight now being handled through marine terminals demands a proportionate increase in the efficiency of its handling. Old methods involving slow and expensive movements of freight must give way to high speed, power appliances of large capacity by which both the cost and time of handling can be materially reduced. The same problems are being faced at railway terminals and in great industrial plants, and many of the methods that are proving successful in such cases can be adopted profitably at marine terminals.

Fig. 4.—Special Tractor Replacing Twenty-one Men

Fig. 5.—Fifty-two Sacks in One Load on Electric Truck

Lumber Operations on the Atlantic Coast

Modern Lumber Steamer and Complete Terminals Under Construction for Shipping Lumber from Florida to New York

To all those interested in lumber and its distribution, and to all concerned in shipping, a description of the lumber operations of the Carpenter, O'Brien Company on the Atlantic coast will be of special interest. It has been assumed by many that the timber adjacent to the Atlantic seaboard has been so depleted that the Pacific coast must be looked to for a supply. While this may be the case in so far as the larger sizes are concerned, it does not apply to the sizes and qualities forming the great bulk of the lumber used on the Atlantic coast. As a matter of fact, during the spring of this year the Carpenter, O'Brien Company, of New York, will be ready to furnish the wholesale market with all grades of the finest Southern long leaf yellow pine and cypress, manufactured in every form ready for use, all of which will be transported by water from Jacksonville, Fla., to the central depot at New York. New mills are now being constructed by this company at Jacksonville in conjunction with sheds, wharfs and various types of machinery for the rapid handling of lumber on a system that is quite new. There is also a terminal yard in New York harbor, which is also fitted up with rapid unloading devices and storage sheds.

It is a fact well recognized by shipowners that short trips and long lays in port form an expensive service. A vessel must be looked upon as a conveyor and should not be used as a warehouse. Any time that a cargo vessel may be at a wharf over and above that essential for loading or unloading by the most efficient means that can be devised is a dead loss to somebody. Invariably this loss becomes a charge on the merchandise, thereby increasing the cost unnecessarily or depriving the merchants of a further possible profit. Before deciding on their plant, therefore, the officers of the Carpenter, O'Brien Company carefully considered every plan available to the end of avoiding delays to their proposed vessels, of securing economy in handling their cargoes in and out and avoiding damage by bruising, breakage or moisture to the lumber in transit, and more particularly to the finer qualities of lumber and dry kiln stock.

The mill products, without exception, will be handled in units 4 feet square varying in length, each unit having two special iron binders to which the crane hooks are attached when hoisting or lowering. They will be brought from the mill to the shipping wharf by monorail conveyors, and will then be stacked on the wharf according to lengths by overhead traveling gantry cranes. The general arrangement of the shipping wharfs at both the New York and Jacksonville terminals is shown in Fig. 1. The

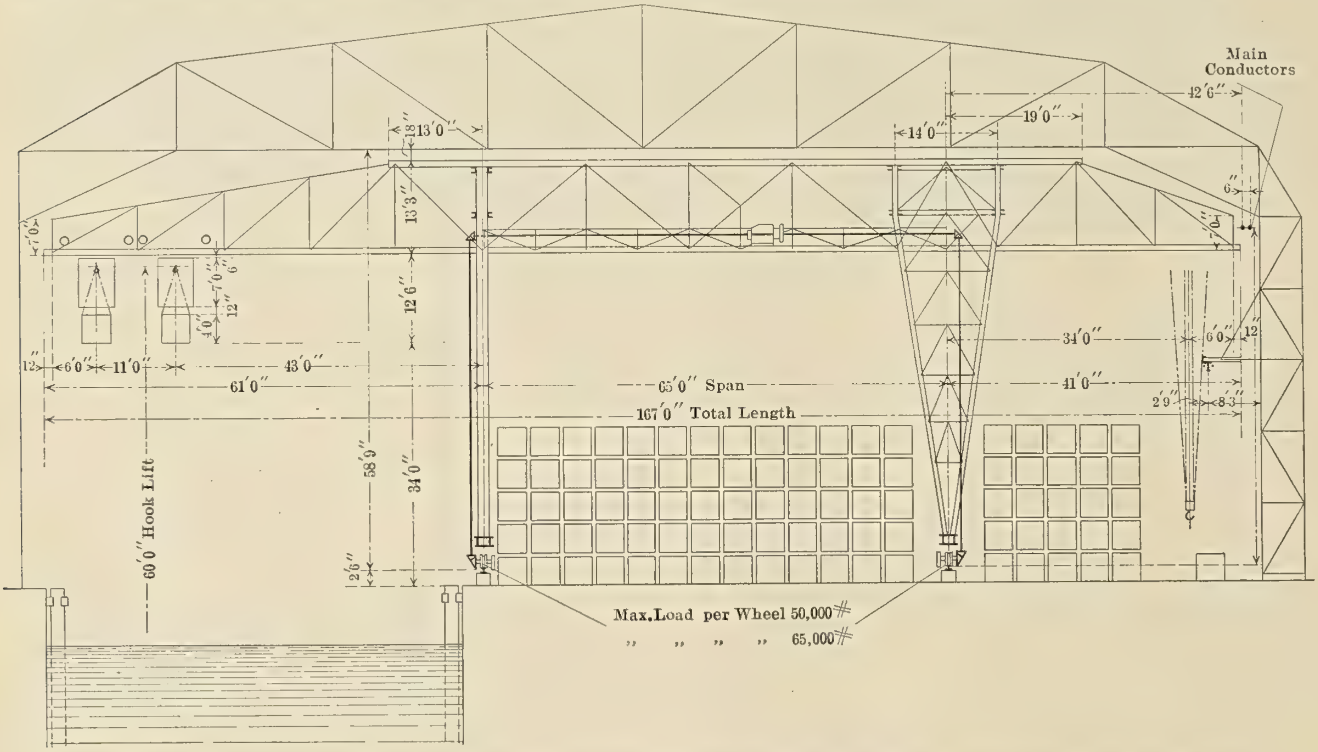


Fig. 1.—General Arrangement of Shipping Wharfs Building at Jacksonville, Fla., and New York for the Carpenter, O'Brien Company

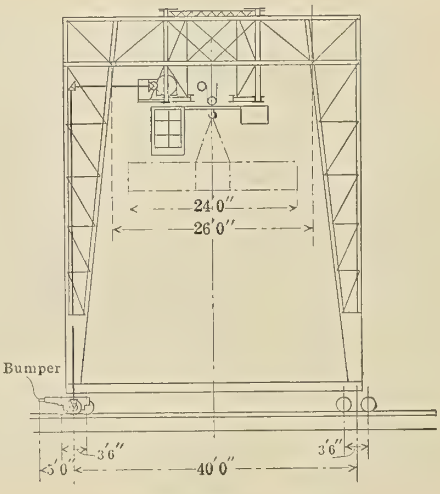


Fig. 2.—End View of Gantry

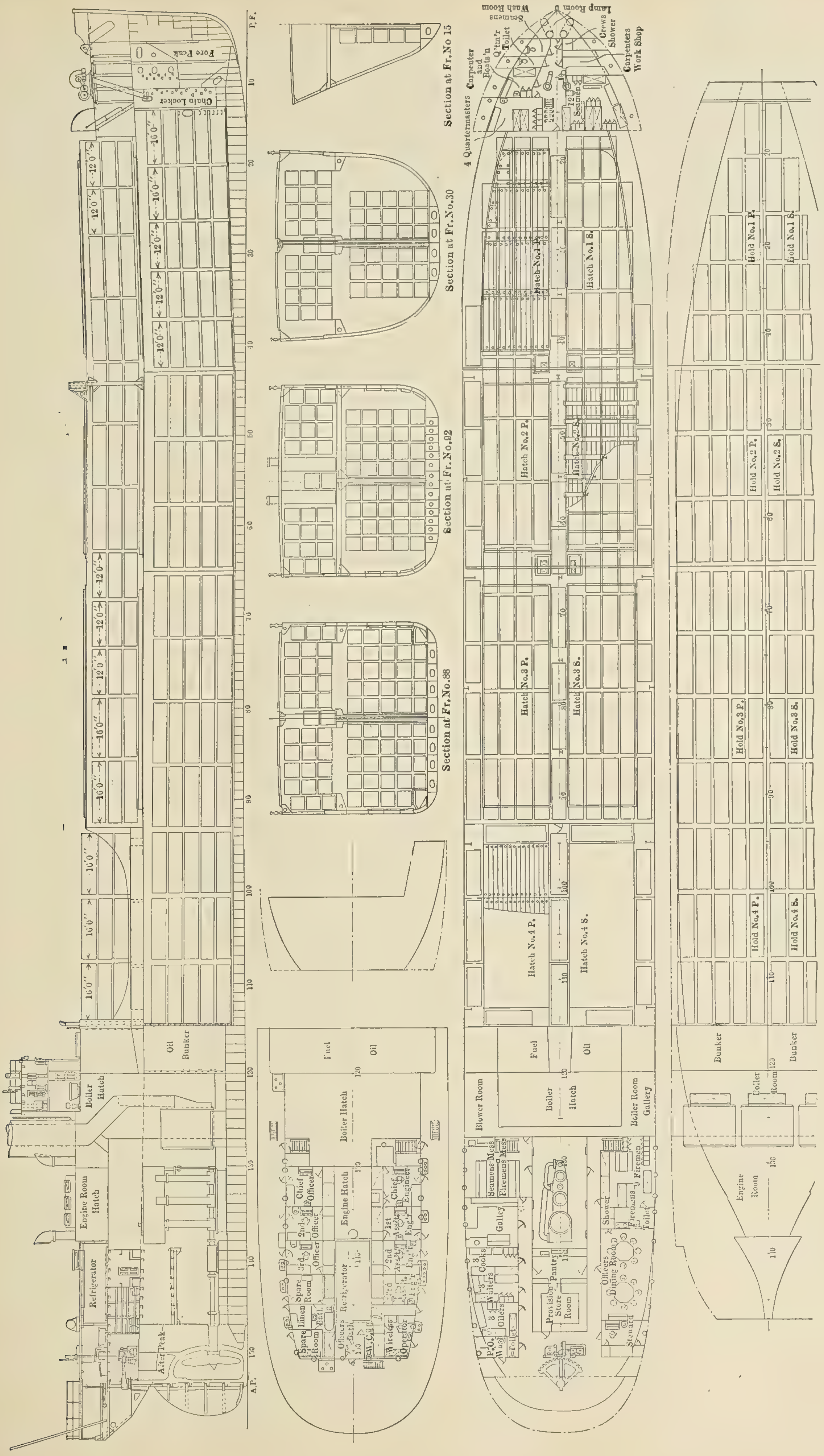


Fig. 3.—General Arrangement Plans of Lumber Steamer *William O'Brien*, Built by the New York Shipbuilding Company, Camden, N. J., from Designs by Edward S. Hough, San Francisco, Cal., for the Carpenter, O'Brien Company

gantries run from end to end of the wharf, spanning the slip. Each gantry has two trolleys having a run the full length of the bridge. The two right angle motions allow every part of the storage space on the wharf and on the ships to be reached by the crane hook. Stevedoring in this case is eliminated.

Turning now to the vessels that will carry the lumber between the terminals, the first of the vessels designed for this service is the *William O'Brien,* shown in Fig. 3, which was designed by Edward S. Hough, naval architect, of San Francisco, Cal. This vessel is designed along the lines of the steamer *Adeline Smith,* the first of the kind, a description of which was published in this journal some months ago. The *William O'Brien* is designed to carry 3,000,000 feet board measure on the unit system. If the lumber were stowed in the usual manner the vessel would carry about 4,000,000 feet. It will be noticed from the drawings that the holds and deck spaces are all arranged in multiples of two and that suitable sparring and shelving is provided so that the units will stow square.

The principal dimensions of the vessel are as follows: Length between perpendiculars, 360 feet; breadth molded, 51 feet; depth molded, 27 feet.

There is a solid plate centerline bulkhead running from the forepeak to the fireroom bulkhead, suitably stiffened to take the place of hold pillars. Hold 2 is used as a deep ballast tank when the ship is light. The hatches are all of such size that the cargo is lowered into place and lifted out without any rehandling or hauling about in the holds. The whole cargo of 3,000,0000 feet will be loaded in one day at the Jacksonville plant and will be discharged in one day at the New York terminal. The vessel will, therefore, become a "conveyor" in the true sense of the word.

The details of the vessel have been worked out with a full knowledge, based on experience, of what a continuous service involves. The boiler capacity is more than ample. Three boilers have been provided in place of the customary two units. Should repairs become necessary to one boiler, there still remains two-thirds of the boiler capacity, which is sufficient to operate the ship. Had she but one boiler under the same conditions, delays would occur, as one boiler would be insufficient to operate the ship at the required speed. The boilers will be oil-fired and the fuel oil will be carried in the athwartship bunkers.

All of the machinery has been provided for along the same lines; ample strength and bearing surfaces are found and the auxiliary machinery is largely interchangeable and readily duplicated. There is one triple expansion engine with cylinders 24¼ inches, 38½ inches and 67 inches diameter by 45 inches stroke. An air pump, two feed and two bilge pumps are driven off the intermediate cylinder crosshead. The condenser has about 3,300 square feet of cooling surface. All of the independent pumps are of the Blake type, with the exception of the ballast pump, which is a De Laval single stage, double suction centrifugal pump, driven by a two-stage De Laval steam turbine. Propulsion is by a four-bladed propeller, 16 feet 6 inches diameter, 13 feet 10 13/16 inches true pitch, with a projected area of 62.65 square feet and a developed area of 70.96 square feet.

No cargo-handling gear is provided on the vessel other than the forward hoist, and this is only for occasional use.

In addition to the steamer described above, the company has in course of construction a fleet of lumber delivery barges, each provided with a revolving luffing steam crane. The barges will go into the steamer's slip at the terminal and will be loaded by the gantrys. They will be towed by the company's own tugs to the various wholesale lumber yards about the harbor, and the lumber will finally be delivered by the steam cranes into the yards in the original binders as made up at the mills.

Progress of U. S. Naval Vessels

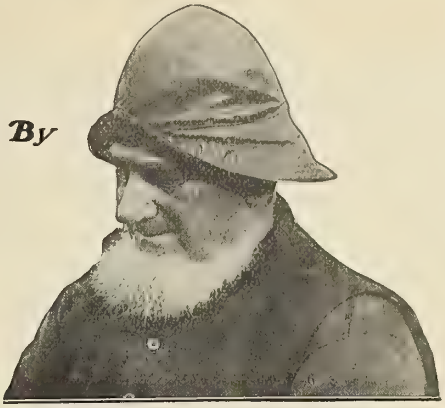
The Bureau of Construction and Repair, Navy Department, reports the following percentage of completion of vessels for the United States navy:

	Tons.	Knots.		1914. Nov. 1.	1915. Feb. 1.
			BATTLESHIPS		
Nevada	28,000	20½	Fore River Shipbuilding Co..	77.8	84.6
Oklahoma ..	28,000	20½	New York Shipbuilding Co..	79.3	87.2
Pennsylvania	31,400	21	Newport News Shipb'ding Co.	58.3	67.1
Arizona	31,400	21	Navy Yard, New York......	36.8	48.1
Mississippi ..	32,000	21	Newport News Shipb'ding Co.	00.0	6.0
Idaho	32,000	21	New York Shipbuilding Co...	00.0	9.9
			TORPEDO BOAT DESTROYERS		
Downes	1,010	29	New York Shipbuilding Co...	95.3	99.2
O'Brien	1,050	29	Wm. Cramp & Sons.........	88.4	93.3
Nicholson ..	1,050	29	Wm. Cramp & Sons.........	86.5	90.2
Winslow ...	1,050	29	Wm. Cramp & Sons.........	82.3	87.0
Cushing	1,050	29	Fore River Shipbuilding Co..	73.7	84.0
Ericsson	1,050	29	New York Shipbuilding Co...	87.4	92.8
Tucker	1,090	29½	Fore River Shipbuilding Co..	18.8	33.2
Conyngham..	1,090	29½	Wm. Cramp & Sons.........	39.5	54.3
Porter	1,090	29½	Wm. Cramp & Sons.........	29.5	50.8
Wadsworth..	1,090	29½	Bath Iron Works...........	66.4	78.6
Jacob Jones.	1,090	29½	New York Shipbuilding Co...	33.7	52.2
Wainwright..	1,090	29½	New York Shipbuilding Co...	33.4	51.7
No. 63......	1,090	29½	Fore River Shipbuilding Co..	00.0	6.4
No. 64......	1,090	29½	Fore River Shipbuilding Co..	00.0	6.4
			SUBMARINE TORPEDO BOATS		
G-2	....	....	Navy Yard, New York.......	89.7	89.7
G-3	....	....	Navy Yard, New York.......	85.7	86.7
K-7	....	....	Union Iron Works..........	98.1	100.0
K-8	....	....	Union Iron Works..........	98.1	100.0
L-1	....	....	Fore River Shipbuilding Co..	67.4	89.6
L-2	....	....	Fore River Shipbuilding Co..	66.2	84.6
L-3	....	....	Fore River Shipbuilding Co..	66.1	75.5
L-4	....	....	Fore River Shipbuilding Co..	65.7	76.0
L-5	....	....	Lake T. B. Co..............	41.2	58.2
L-6	....	....	Lake T. B. Co. (Long Beach, Cal.)	41.7	52.7
L-7	....	....	Lake T. B. Co. (Long Beach, Cal.)	39.7	51.6
M-1	....	....	Fore River Shipbuilding Co..	50.6	63.4
L-8	....	....	Navy Yard, P'tsmouth, N. H.	0.0	3.0
L-9	....	....	Fore River Shipbuilding Co..	24.9	50.0
L-10	....	....	Fore River Shipbuilding Co..	23.8	45.6
L-11	....	....	Fore River Shipbuilding Co..	0.0	3.2

Reasons for Advocating Electrical Propulsion

While there has been considerable skepticism on the part of marine engineers as to the successful application of electricity to the propulsion of ships, this has been due principally to the unfamiliarity of marine engineers with the handling of large units of electrical machinery operating at high voltage. The direct-connected steam engine, especially of the reciprocating type, is an old and tried friend. Every marine engineer has been shipmates with this type of machinery from the time when he first went to sea. He is thoroughly familiar with its characteristics and capabilities and is fully prepared to meet any emergency that may arise. This knowledge has inspired in himself confidence in his own powers as master of the powerful machinery under his control, and the introduction of a new and unfamiliar type of machinery is naturally not met with favor on his part. The experience gained from the *Jupiter,* however, has shown that the burdens of the engine-room staff are materially lightened on an electrically propelled vessel. In place of the heavy throttles that must be opened and closed there are light, easily-handled oil switches and a speed controller that can be handled with one finger. Fewer men are required on watch in the engine room and, in a rough sea, there is no racing of the machinery, with the consequent constant attention of the engine-room watch. The machinery responds promptly to changes of speed, and full power is available for backing, making the vessel particularly handy for maneuvering. With all these advantages in view it will probably not be a difficult task to win over the marine engineer to the ranks of the advocates of electrical propulsion.

Economy Talks By "Old Scotch"



Lubrication

There is an old saying that there are more ways than one to kill a cat, and in this economy on shipboard there are more ways than those I have already written about to save money.

Next to fuel, probably the most expensive item in the operating expenses on board ship is lubricating oil, and on almost any big ship there are lots of ways of cutting down that expense. When I first went to sea we used nothing but hog grease, or lard oil, as they called it, and we had to pay from 90 cents (3/9) to $1.10 (4/7) a gallon for it; that was indeed some expense.

It was not only expensive, but it had other bad features. Those of you who have never smelled rotting lard oil in the bilges of a wooden steamer do not really know what perfume is. Besides that, if you had a burn or a cut on your hands or face, the smarting pain the use of lard oil would give you, on account of the salt, used to preserve it, was something to remember, and make you thank your stars that coal oil was discovered out in Pennsylvania before the most of you were born.

The fine grades of mineral oil you use these days at a cost of thirty to forty cents (1/3 to 1/8) a gallon are also something to be thankful for. Because it is much cheaper than lard oil used to be, is, however, no reason why it should be wasted. I'll venture to say that on almost any steamer running to-day a saving of from ten to fifty percent in oil bills can be made if the men in charge will go after the oilers who are responsible for the use of the lubricants.

If you really want to find out how little oil a marine engine can run on with safety, just get caught out at sea about a thousand miles from home some time, and find that owing to the gage glass on your oil tank being filled, with the gage cocks at top and bottom shut off, you thought you had twice as much oil on hand as you really had. That occurred to me one time, and I have no doubts but what the same experience has fallen to the lot of many other engineers. It kind of makes you feel sick to find that you have only two days' quantity of oil on hand when you thought you had at least enough for a week's run. The fact that I am sitting up writing this dope is evidence that we got into port, even if we did have such a small quantity of oil on hand

"How did we do it?" did I hear you say? Well, my boy, it was simply a case of economy applied strictly on the ground of necessity. We made every drop of oil count, and we got into port with about ten gallons of oil to spare.

The first thing I did was to call my assistants and all the oilers and read them the riot act about being careful with the oil. And believe me, they were careful, too. The first thing they did was to cut out all the automatic lubricators, which are at all times both a blessing and a curse. A blessing, because if an oiler loafs on his job the oil is sure to be fed to the working parts, and a curse, because the natural tendency is to let them run so strong to make doubly sure that all the journals get oiled that about twice as much is used as is really needed. By cutting out all those oil manifolds and oiling with a squirt can the quantity we used was at once reduced over a half. Of course, there were no unnecessary flourishes given the oil can, and every time an oil cup was aimed at the stream of oil came pretty near to hitting the bull's eye. Then, too, we dug up out of a storeroom a couple of old oil cans and rigged up a kind of filter whereby we could strain the oil caught in the drip pans through an old woolen undershirt, thus saving much of the oil to use over again on the engine.

It surprised all of us how little oil that old engine needed, as compared to the amount we had been giving her when we thought we had plenty of oil in the tanks. The next voyage we made we adopted the same tactics as we had been using in those few days of hard times, and if that old hooker is still running I'll bet that they are using that reduced amount yet.

That experience taught me a good lesson, and one that I have profited by ever since. With an ordinary automatic lubricator secured to the engine casing I usually cut out all the oil drips except the two to the crosshead pins on each cylinder, and make the oilers oil all the other journals by hand. Crankpins, if watched closely, can be oiled by hand entirely, although on some engines it is advisable to have a steady flow of oil from the lubricator. Nine times out of ten, though, unless you watch the drops yourself, the oiler will let it run too freely and waste about half as much as is put on.

Some engineers believe in using compound on small journals where there is little motion, and I believe there is economy in that. The great oil-users are the crosshead pins, crankpins, main bearings and the thrust. It is undoubtedly very economical to catch the oil from these journals in drip pans and strain it in a filter, of which there are several good types on the market. Oil can be used a number of times without losing its lubricating quality, and the main object of the filtration process is to remove any dirt from the oil.

Of course, we all know that there should be a certain amount of the waste oil run into the engine-room bilges, as there is nothing better to preserve the steel around the inaccessible parts of the engine foundation than oil sloshed around in the bilge water. I'm not altogether sure if it isn't a good idea to let some of the oil from the engine-room bilge run into the fireroom bilges through the sluice valves, as the Lord knows it is a pretty hard game to keep the hull plates and frames under the boilers from rusting out in these steel ships we are running.

Yours for economy,

Old Scotch

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT*

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

EDITOR'S NOTE.—In reply to a question on page 38 of the January, 1915, issue, regarding the use of jet condensers with turbines when fresh water is available for circulating water, the answer stated that jet condensers should never be used, as this type of condenser is unsuitable for the production of the high vacua essential to good efficiencies in turbine installations. In view of the fact that jet condensers with rotary pumps are used extensively in shore turbine installations, giving high vacua and good economy, it should be distinctly understood that the answer given in the January issue referred only to present ship practice, that is, to the type of marine jet condenser with reciprocating pumps in common use on fresh water. The answer as given is true for that type, but does not apply to jet condensers now common in shore turbine installations, which have pumps of the Leblanc, Thyssen or Delaporte types. These pumps are valveless rotating pumps that draw air out of the condenser by entraining it between pellets of water or in a jet discharged at high velocity into the pipe from the condenser. Pumps of this sort will handle a large volume of air and give vacua equal to those obtained with surface condensers.

Q.—How can I find the two-thirds power of a displacement? STUDENT.

A.—The easiest way is to square the number and then extract the cube root of this square. If a table of squares and cubes is available, it simply means leveling up the two entries in the table.

Q.—What is the largest Diesel engine installation in a ship at the present time? H. B. H.

A.—The largest total horsepower is in the *Fionia*, which has two 6-cylinder Diesel engines of 2,000 brake horsepower each. The largest horsepower per cylinder is a bit over 500.

Q.—How do you determine the number of expansions for a triple-expansion engine of known dimensions? S.

A.—The number of expansions in its commonly accepted significance is the ratio of the volume of the low-pressure cylinder to the volume of the high-pressure cylinder at the cutoff, clearances neglected.

Q.—Why are torsion-meters not used for determining the shaft horsepower of reciprocating engines? P. S. H.

A.—Torsion-meters are at their best when measuring the output from engines having a constant turning-moment or torque, as in the case of turbines, and even here the torsional oscillation of the shaft from the thrust-block to the propeller, caused by irregularities in propeller action, gives trouble. In the case of a reciprocating engine the torque is so irregular at different angles of rotation that torsion-meters give unsatisfactory results. There have been instances, however, of torsion-meter applications to reciprocating engines, but generally with poor results.

Q.—In reading the figures which are placed at the bow and stern for indicating the draft, should the figure be read to its top or bottom or centerline? DRAFT.

A.—Figures for draft read to the lowest point of the figure and are customarily six inches high, so that, if the water were half way up on 14, the draft would be 14 feet 3 inches, or, if just covering it, 14 feet 6 inches.

Q.—Will you please explain the following: In a triple-expansion condensing engine is the vacuum produced by the air pump effective only in the low-pressure cylinder, or does it cause a reduction of pressure below that of the atmosphere in the intermediate- and high-pressure cylinders as well? J. R. P.

A.—The vacuum affects the pressure in all cylinders, but most in the low-pressure cylinder, and least in the high-pressure cylinder. For the range of pressures customarily met with, the only cylinder in which the pressure falls below the atmospheric pressure is the low-pressure cylinder.

Q.—We have a 2,500 indicated horsepower, coal-burning freighter, with a radius of action of about 3,000 miles. How much of a saving in weight of fuel carried could be expected if oil-burning apparatus were installed? CHIEF.

A.—A moderate value of coal per indicated horsepower per hour for vessels of this character is from 1.6 to 1.8 pounds, so that for the time required to steam 3,000 miles (assuming a speed of 10 knots) would be about

$$\frac{1.8 \times 3{,}000 \times 2{,}500}{10 \times 2{,}240} = 603 \text{ tons.}$$

For oil fuel probably 1.1 pounds is a conservative figure, which would give 361 tons for the 3,000 miles, or a saving of 235 tons deadweight and the further saving in volume of the entire space now used for coal, as the oil fuel would probably be carried in the double bottom.

Q.—I have frequently of late seen references to the "Michell" thrust bearing, and judge that it is some new kind of thrust bearing for ships. Can you give me a brief description of it, and tell wherein it differs from the standard type in use? T. B.

A.—The principle of the "Michell" bearing is that of automatically forced lubrication. The thrust of the shaft is transmitted to the stationary part of the bearing through a series of sectors each supported at its center of pressure, which is two-thirds its length from the leading edge. When running, each block takes a slight tilt, and the space between it and the opposing collar is at the leading edge about twice that at the trailing edge. Oil enters and is forced along the narrowing channel, so that a film is always maintained between the surfaces. The theoretical work upon lubrication on which the practical design is based was derived by Osborne Reynolds in 1886, and the earliest patents were brought out by "Michell" in 1905. Since then there have been several thrust bearings of this same general character. One made in this country is the "Kingsbury" (patented 1910 and now installed on the U. S. collier *Neptune*). Bearings of this sort have been shown to withstand remarkable pressures. The normal type of thrust bearing is rarely designed to carry much over 50 pounds per square inch, and with turbines, where the pressure is steady, trouble was found

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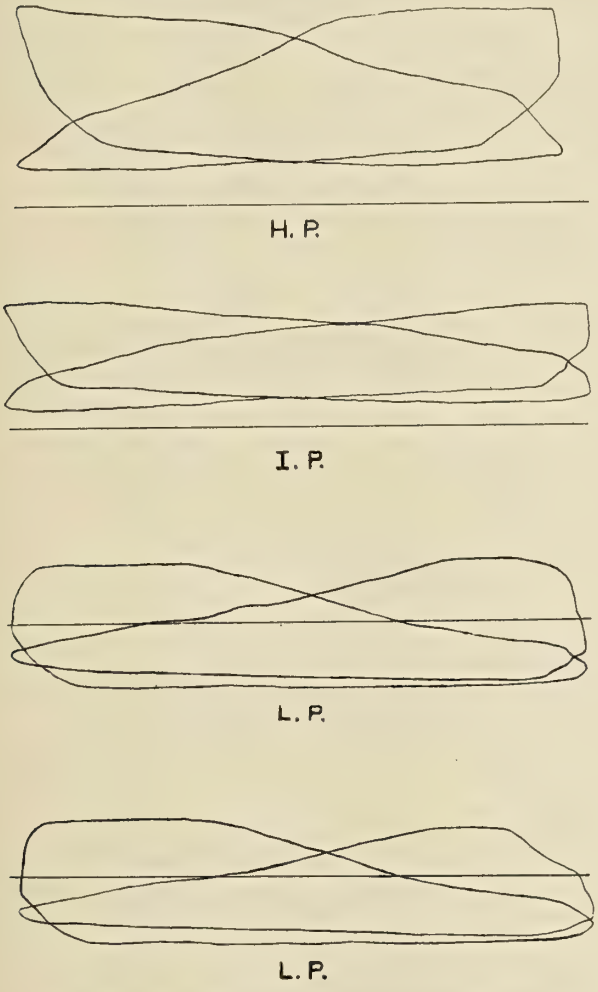
*Assistant Professor of Naval Architecture, Massachusetts Institute of Technology, Boston, Mass.

at even low pressures, due to the oil being squeezed out. Bearings of the "Michell" type are customarily designed to operate at thrusts of 500 pounds per square inch and often are operated as high as 1,500 pounds per square inch. In fact, in an experimental bearing of the "Kingsbury" type, made by the Westinghouse Company, pressures up to 10,000 pounds per square inch were attained with no heating, although at this pressure the white metal was squeezed out and the pressure had to be reduced. The friction losses in a bearing of this sort are about 1/15 of those in a standard bearing and but one thrust collar is customary.

Q.—Inclosed are indicator cards taken from the engines of one of the Japanese trans-Pacific Ocean liners. Will you please explain the cause of the defects in the low-pressure cards, and how they can be remedied?
S. M.

A.—The high- and intermediate-pressure cards and the top card of the low-pressure cylinder need no comment. The abnormalities apparent in the card from the bottom



Cards from Four-Cylinder, Triple-Expansion Engine

end of the low-pressure cylinder can be explained by an insufficiently opened indicator cock, as there are evidences of continuous throttling and delay in events. This would explain the difference in cards taken at different times. Possibly the three-way cock, if used, sticks, or is improperly installed. There is no defect in valve or valve setting which will produce all the irregularities shown.

Q.—Please calculate horsepower from the inclosed cards and suggest any changes that may be desirable.
H. P.

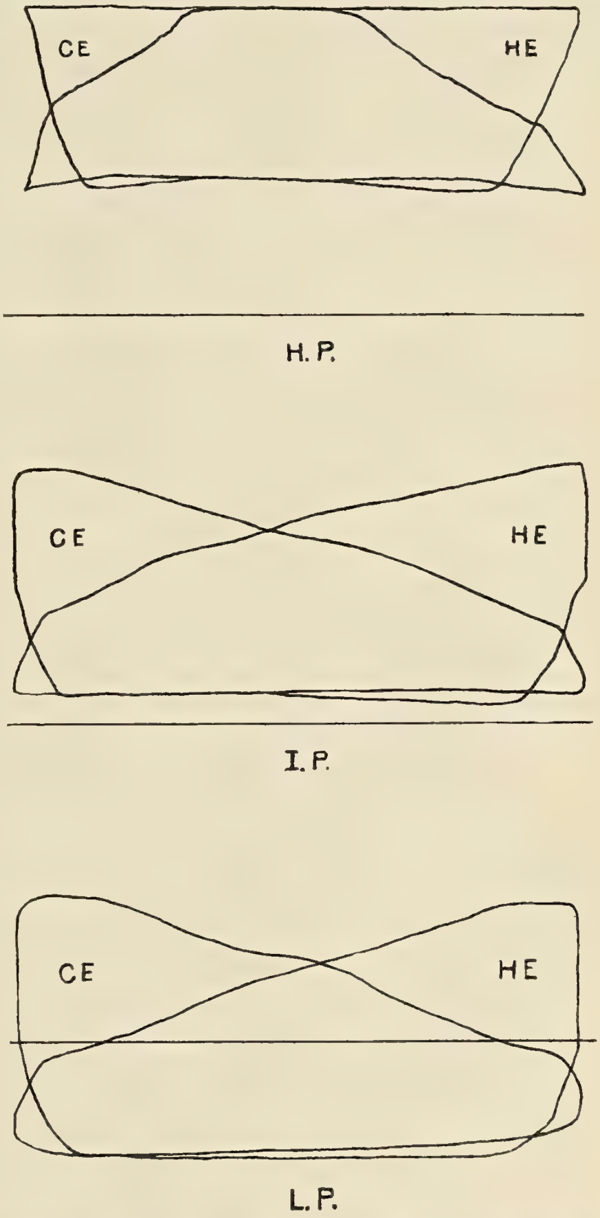
A.—The tabulation of horsepower follows, and it should be noted that the high-pressure cylinder is not doing its share of the work.

TUGBOAT ENGINE, 17", 25", 43" BY 30" STROKE. BOILER PRESSURE 190 LBS. VACUUM, 26". REVOLUTIONS PER MINUTE, 94.

Cylinder End.	Area of Card Sq. In.	Length of Card In.	Spring Lbs. per In.	M.E.P.	I. H. P. Per Card.	I. H. P. Per Cylinder.
H. P. (H E)....	3.56	3.76	80	75.7	122.2	......
H. P. (C E)....	3.25	3.76	80	69.2	111.0	233.2
I. P. (H E).....	4.11	3.83	40	42.9	150.0	......
I. P. (C E).....	3.74	3.81	40	39.3	134.2	284.2
L. P. (H E).....	4.40	3.79	12	13.94	144.1	......
L. P. (C E).....	4.44	3.76	12	14.17	145.3	289.7

Total indicated horsepower, 806.7.

The intermediate-pressure and low-pressure cards are excellent and need no comment. The high-pressure card



Cards from Tugboat Engine. Piston Rods, All 3⅞ Inches Diameter; High-Pressure Piston Valve Lead, ¼ Inch on Each End, or 3/16 Inch at Top and 5/16 Inch at Bottom in Working Condition; First Receiver Pressure, 70 Pounds; Intermediate Pressure Piston Valve Lead, ⅛ Inch at Top and 3/16 Inch at Bottom; Second Receiver Pressure, 16 Pounds

gives evidence of too early admission on both ends of the cylinder and the events of cut-off and compression occur at percentages of the stroke which are more unequal than should be. The remedies for these are: First, to decrease the lead by reducing the angular advance, which would improve the heels of the cards; and, second, shorten

the valve rod and equalize the events of stroke a small amount. If these are carefully done, and cards taken between changes to note the effect of changes and *but one thing changed at a time,* it should be possible to increase the horsepower in this cylinder by 10 percent to 20 percent, especially if the serious wire drawing into the receiver (shown by the curved back-pressure lines) could be remedied. This can be done, if the valve does not at present entirely uncover the exhaust ports, by increasing the eccentricity, which would give increased travel and therefore port-opening. The above discussion is on the assumption that the valve is direct-acting. If it is indirect, reverse the changes to conform. A direct valve is one which governs admission and cut-off by the outside laps.

Q.—Will you please explain the following regarding the question published in the January, 1915, issue, which asks for the horsepower of a sternwheel towboat driven by compound tandem condensing engines? In the answer it is stated that you doubt if such an engine as described will produce 3,700 horsepower, and you back up your statement by figures. I followed the calculations until it comes to the indicated horsepower formula, where the result given is 1,470 horsepower for one engine. I agree with all your figures except that of the area of the surface worked against. You give 3,117, which is the area of the low-pressure only. Why should not the high-pressure also be taken into consideration? If it were, we should get the following:

$$I.\ H.\ P. = \frac{2 \times 64.9 \times 12 \times (3117 + 618) \times 10}{33{,}000}.$$

I. H. P. = 1,760 for one engine, or 3,520 horsepower for two engines. J. M. E.

A.—In estimating the mean effective pressure for any multiple-expansion engine, it is customary to calculate the pressure that would be required if the work were all done in the low-pressure cylinder. This is called the mean effective pressure referred to the low-pressure cylinder and the calculation for horsepower then becomes identical with the calculation for a single-cylinder engine. For a compound engine the referred mean effective pressure is

$$M.\ E.\ P.\ \text{(referred)} = \text{low-pressure } M.\ E.\ P. + \frac{\text{high pressure } M.\ E.\ P.}{\text{ratio low pressure to high pressure}}$$

and for a triple-expansion engine

$$M.\ E.\ P.\ \text{(referred)} = \text{low-pressure } M.\ E.\ P. + \frac{\text{intermediate pressure } M.\ E.\ P.}{\text{ratio low pressure to intermediate pressure}} + \frac{\text{high pressure } M.\ E.\ P.}{\text{ratio low pressure to high pressure}}$$

The mean effective pressure used in the calculation mentioned was the referred mean effective pressure, and, therefore, already included the high-pressure mean effective pressure. The correct indicated horsepower is 1,470, as formerly given.

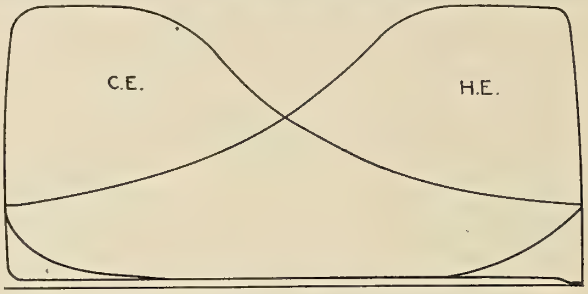
Q.—(a) I am inclosing three indicator diagrams and would like to have the exact horsepower of same calculated. These cards were taken off of one of my main engines.
(b) Why do vacuum gages read in inches instead of pounds?
(c) Why is the low-pressure cylinder of a compound engine made twice as large as the high-pressure cylinder? W.

A.—(a) The horsepower from the cards (neglecting the piston rods, as no data are given) is as follows:

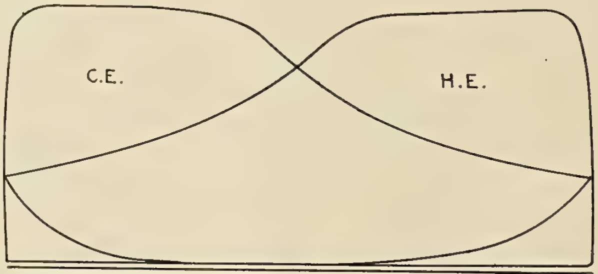
Card No.	Cut-Off	M. E. P.	I. H. P. (total)	R. P. M.
1	5/16	115 H. E. 111 C. E.	208	17
2	3/8	118.6 H. E. 117.8 C. E.	204	16
3	1/2	129 H. E. 125.4 C. E.	247	18

If they were reduced to the same revolutions per minute, say 17, the indicated horsepower from the three cards would be 208, 217 and 233, respectively, which well illustrates the effect of increasing cut-off. The cards would be improved if release occurred earlier. If the engine has a slide valve, increase the angular advance, and if poppet valves, arrange for earlier admission and release.

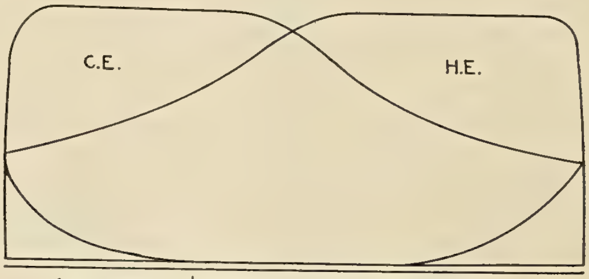
(b) By vacuum, in the commonly accepted engineering sense of the word, we mean the amount by which a pressure is less than that of the atmosphere. The pressure due to the atmosphere is measured by an instrument called a barometer, which records the height to which a column of mercury would be sucked up in a tube by a perfect vacuum, or, more correctly, the height at which the atmospheric pressure will maintain the column of mercury.



CUT-OFF AT 5/16 STROKE. BOILER PRESSURE = 190
R.P.M.=17



CUT-OFF AT 3/8 STROKE. BOILER PRESSURE = 185
R.P.M.=16



CUT-OFF AT 1/2 STROKE. BOILER PRESSURE = 191
R.P.M. = 18

Cards from Single-Cylinder Engine, 18 Inches Diameter by 84 Inches Stroke

This is not constant, but varies from day to day. All steam engineering gages always read from atmospheric pressure, as a basis or zero, and a vacuum gage reads the amount by which pressures are less than the atmospheric pressure. The barometer at the time the vacuum gage is read gives the value of a perfect vacuum in inches of mercury and the relative sufficiency of the vacuum in hand can best be determined if it reads in the same units as those common for indicating the perfect vacuum, namely: inches.

(c) One pound of steam increases in volume as the pressure on it decreases. After a certain number of pounds of steam have gone into the high-pressure cylinder up to the point of cut-off the steam expands and drives the piston before it. The steam is then exhausted into the receiver at this lower pressure and increased volume. The low-pressure cylinder, in order to take the steam and expand it still further, must be of a volume larger than the high-pressure cylinder by approximately the amount of the expansion in the high-pressure cylinder.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries — Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Insignificant Omission the Cause of Great Damage

During a recent full-power regulation trial trip with a high-powered ship fitted with watertube boilers of an approved type, explosions in four out of the total number of 16 boilers wrought terrible injury and death to a number of men, with considerable damage to several of the boilers.

The cause of this accident has been the subject of careful investigation, and it may be stated that no effort has been spared to ascertain all the facts which may have conduced in bringing about the result. So far as the investigation has extended, the primary cause, as is the cause in nearly all boiler explosions, was due to low water, or, more nearly, to a lack of water, as a result of obstructed feed.

The boilers in the ship in question are arranged in eight boiler compartments, each with two boilers. The main feed system consists of two main feed tanks, one in each engine room, four main feed pumps and two hotwell pumps, together with other feed apparatus in duplicate divided equally in the two engine rooms. There are two independent feed lines, one on each side of the ship, with proper cross-connections. The main suctions consist of 6½-inch pipes to each feed tank with branch 2-inch pipes to the reserve feed tanks. The main feed tanks are of the ordinary tank and filter type and had originally a grid-iron, float-and-lever-operated valve at the suction, which was placed at the bottom. This valve was at some time removed, the particular reason for which being not definitely known, but is supposed to have originated with the idea of obviating the possibility of accidents due to the inefficiency incident upon the operation of float valves. In this connection, it might be mentioned, that an automatically closing valve on the main feed suction in the feed tank is placed there to prevent air from entering the feed suction when for any cause the water becomes exhausted in the tank. This arrangement is, however, not used in present-day machinery installations, but instead thereof an internal pipe in the form of a gooseneck or elbow is used with the suction at the bottom or side of tank, respectively. Suffice it to say, that the float valve was taken out and a strainer put in its place. It seems the top cover of this strainer was not secured by either bolts or rivets, but held in place by some other means more or less insecure.

The investigation has divulged the following facts:

1. That the starboard feed suction line failed, due to some obstruction within the feed tanks.

2. That this obstruction was found to consist in the top of the strainer having worked loose; then it dropped to the bottom of the box and closed up the opening connecting with the suction pipe. The plate top was held down by a pressure approximately equivalent to the pressure head in the tank and suction head in the feed suction pipe, in that way effectively closing the opening.

3. The starboard tank was overflowing while the port tank was rapidly being emptied, owing to the increased demand made upon it.

4. Lack of water in the boilers was indicated by its disappearance in the gage glass of each boiler.

5. Fires were hauled on all boilers except one, and several of the boilers were pumped to steaming level with salt water.

The first explosion occurred just before the completion of the trial, successively followed by explosions in three other boilers. About 12 minutes lapsed between the first and last boiler explosion.

The pressure on the feed line ranged between 250 and 350 pounds, while the average pressure in the boilers was 170 pounds, the air pressure in the boiler rooms averaging two inches. The starboard feed tank had been overflowing during 12 to 15 minutes, showing the obstruction having lasted for about this time.

The impressions received by different observers at the time of explosions are described as follows:

The firebox doors all flew open and flame, coals and smoke came out of the doors.

While closing the blower on one boiler and walking over towards another boiler the first boiler blew up. When it blew up it was dry. There was no steam, no water, nor vapor, and just blew out a black fog of gas and dirt and flame through the center. There was no steam to amount to anything in the fireroom.

While standing between the feed pump and the throttle of the blower the explosion occurred. It blew me out into the next fireroom, the concussion was so great.

The fire doors on the boilers were not of the inswinging type but of the ordinary side-hinged outward-swinging type. Those of the doors which were shut and locked remained in that state with a few exceptions; those that were not locked blew open.

The damage done to the boilers consisted chiefly in tubes pulling out, various parts warping, and blistering and calking in drums being started.

The explosions occurred in the forward boilers, the after boilers getting the water first, being nearer the source of supply.

The damage done to the boilers, while considerable, was very insignificant compared with the injuries sustained by the men on watch, many of whom were killed and a great number severely injured.

The lesson to be drawn from this accident may be put down in these few words: No detail is too small to receive the most careful scrutiny, thought and attention. A couple of half-inch bolts in this case might have averted this accident.

EYE.

Handy Kinks for the Engineer

In removing or replacing cylinder heads or valve-chest covers, studs are often bruised so that the nuts cannot be replaced without doctoring up the threads with what the boys call "a three square file." This process is long and the delay is annoying. To get around this trouble I take a spare nut and with a round file, file inside the nut, making it into a die. Leaving the lands quite narrow, I heat this filed nut up to a low red heat and cyanide the inside, of course reheating the nut so that the cyanide

will sink in. This produces a very serviceable die, which can be run over a bruised stud, leaving it in much better shape than if filed.

Every engine of what we now call the "old style" has certain parts of its mechanism set and then center-punched, and these marks being recorded as to their relative positions by trams; these trams often get lost or bent, with the result that very important records are entirely lost. To prevent this trouble I select some convenient surface on the engine, quite often on the engine frame, or perhaps on the upper side of the valve chest or in fact any place that can be conveniently reached and is of sufficient extent. Into this surface I drill an eighth-inch hole and plug it with a piece of brass wire and center-punch it. Then taking one of the trams, I place one of its points in this center-punch and scratch a radius on the surface selected with the other point; on this radius I drill a second hole, plugging it as before; I then scribe the arc again with the tram, and center-punch a second point in the second plug. Between these two plugs I draw a line with the scriber and stamp what the distance represents, as for instance: if the tram was for locating the position of the high-pressure valve stems, I would simply use the letters H. P. V. S.

It is quite evident that this system can be carried out easily where the trams have points of even lengths; but where they are not of even length the system has to be somewhat modified. If the difference in length of points is not great, one of the plugs can be left long enough to make up the difference; the objection to this, however, is that a peg which extends out might be accidentally bent or even carried away, so I have quite often resorted to taking a strip of steel, say five-eighths thick and of sufficient depth to make up the greatest difference in any of the tram legs and screwing the piece in a convenient position on the engine frame, or elsewhere, and center-punching its edge, working down its depth with a file or a shaper, if available, for the various length of legs of the trams.

While a ship's engine room is pretty well provided with tools and supplies, I have almost always found that during a voyage some little tinkering has to be done that draws on the tool chests of the engine-room force. The captain and all the deck officers seem to think that an engineer officer is able to make any kind of repairs from the ship's clock to the rudder stock. I have always found it extremely convenient to carry with me a small assortment of drill rods, or what they used to call "Stubbs' wire," together with drills of both body and tapping size for these rods; also a "jamb plate" or die plate for them, and taps. These wires are usually required in short lengths not over, say, three inches, and I have found that after a short time they all got mixed up in my tool chest and I could rarely find just the size that I wanted, or the tap or drill, without completely cleaning house. To overcome this difficulty I have lately bought at a drug store or chemist's, as they call it over in the Old Country—long, narrow bottles and used these to carry each size of drill rod, together with the drills and tap. It would perhaps be better if I could get metal tubes instead of glass bottles, but I have been unable to find them; yet the glass bottles have the advantage of allowing one to see what is in them without pouring the contents out.

One curious thing seems to take place with these glass bottles—they break from no apparent cause. I thought at first the breakage arose from carelessness and from being knocked about in my tool chest, but I am convinced that this is not the reason, as I have kept the bottles in places where they could not get knocked about and still the smashing continues. A brother engineer tells me that the only way to stop this breakage is to line the bottles with paper and stuff a piece of cotton in the bottom of the bottles so as to prevent the metal from coming in contact with the glass. This seems to me quite reasonable and possible, as cleaning a gage glass with anything but a stick and a hunk of waste is never allowed. I have tried putting a small round file in a gage glass and shaking it about a bit and then laying it away, only to find that in a short time the glass was in pieces.

Returning to the subject of replacing cylinder and valve-chest covers, I saw in a French-built engine a very convenient idea to assist in doing this work; it consisted of having two of the studs, which were opposite each other, made considerably longer than the other studs, but one of these two long studs was an inch longer than its mate. The thread on these long studs being turned off above the regular length of stud, thus presenting two pegs, the cylinder cover could be very easily lowered down and guided onto the longer peg or stud and then onto the second, thus bringing all the stud holes in the cover to properly register with their respective studs. When the valve-chest cover was to be handled the longer of the two studs was placed in the upper center of the valve-chest edge, while the second was directly below it, in the lower edge.

In this same French engine the packing of the cylinder heads was quite novel, at least to me. Just inside the cylinder studs there was turned a V-shaped groove and in the cylinder cover was turned a corresponding groove. A piece of thin copper tubing of proper diameter was rolled up to just drop into the groove. The joint being hard-soldered, this tube was well annealed and of sufficient diameter to allow the cover to pinch down on it. The joint, the engineer assured me, never leaked, and he used the same piece of tubing over and over again, only reannealing it from time to time. Jack.

Faulty Designing of Marine Boilers

The article on faulty designing of marine boilers by "J. S.," published in the October, 1914, issue of International Marine Engineering, was of much interest to the writer. Although much has been written about the Scotch marine boiler and vast improvements have been made in such boilers in recent years, there still remain many points for discussion. There is also ample room for various further improvements to be made. I am sure a thorough discussion by the readers of this practical journal would do much in this respect.

Referring to the remarks by "J. S." regarding a marine boiler on a coastwise tug, special attention is called to the bulging of the backs of combustion chambers, due to the 7½-inch pitch of the stays. "J. S." seems to think that this pitch is too great.

All other points being equal, the above pitch is quite in order. The writer does not believe that the fact that these stays were pitched 7½ inches apart was actually the cause of the trouble. There are other factors which would be more likely to cause some trouble or bulging, even with a much less pitch.

The writer has often wondered that there are not many more cases of boiler explosions on board tug boats, for in many cases the abuse and neglect of boilers on tug boats are criminal. Some time ago the writer had occasion to board a sea-going tug, and on going below with the chief, to the writer's surprise no water was visible in the gage

glass, but a plug of cylinder oil stood nearly an inch above the bottom nut. The writer was informed by the chief that there was plenty of water in the boiler. He considered that as long as 2 inches of water was over the combustion-chamber top everything was all right. In fact, it was his practice to carry the water at this level, as he claimed that it gave more steam space.

As a rule, tug boats work very long hours, and the boilers are kept under steam without cleaning for long periods, with the result that often serious scaling takes place. With high steam pressures, it is not surprising to read about collapsed furnaces and distorted and bulged plates. The marvel is that the actual cases of serious accidents are so few.

In the case that "J. S." refers to, it would interest the writer to know if the fire bars were carried clear back to the back of the combustion chamber. I would also like to know the grate area, the diameter of the smoke tubes, and also the diameter and length of the boiler.

Referring to the next case cited by "J. S.," in which Howden's forced draft was used, the failure here again may not be due to defective staying, but rather from defective circulation. No doubt, "J. S." is right in his remarks in this instance, where he refers to the narrow water spaces between the back of the combustion chamber and the back of the boiler, more especially if the back of the combustion chamber is straight. When forced draft is used it is certainly bad practice to have the back of the combustion chamber dirty. The back of the combustion chamber should always have as much slope as possible to allow the globules of steam to be more readily liberated. A straight combustion-chamber back, with a restricted water space, is fatal to good circulation.

In the next case cited, where forced draft was also used, the writer is firmly of the opinion that the trouble was entirely due to overheating, due to defective circulation. The fact that in this case there was no break in the horizontal line of tubes, and the lower row of tubes was only about 4½ inches or so above the furnaces, would be quite enough to court disaster with forced draft and bad circulation. A boiler intended for forced draft calls for the most careful design and thorough attention to the minor details. The water spaces and the arrangement of tubes must have special consideration, as upon these points hang the merit of the boiler. The writer has come across cases in which boilers of equal size, that is, 8 feet by 8 feet, have had smoke tube surfaces alone varying by over 60 square feet. I have also come across cases where the bottom of the combustion chamber gave only 1½ inches clearance from the shell plate.

The writer long ago came to the conclusion that some builders never considered the question of combustion or fire grates. They seem to think this subject requires no consideration, and as long as a few fire bars are thrown into the furnace of any length that happens to be handy, it needs no further consideration. The writer has no hesitation in stating that an ill-designed and ill-proportioned fire grate and bridge can easily be made to count for a shortage of power to nearly 50 percent of the boiler's available power.

Another very common error in regard to furnace fitting where it has been found that the boilers are too small for the engines and it is desired to improve matters, the fire bars have been carried clear back to the back of the combustion chamber, with the intention of increasing the power of the boiler from the additional grate area. It would interest the writer very much to hear of a case where this method has been a thorough success. Personally, he has not seen one yet, but, on the contrary, he has seen good boilers practically ruined by the adoption of this plan.

There is a limit to the power which can be generated in any boiler, and when, through an error in design, or through an attempt at false economy, a boiler much too small, even when worked at its maximum power, is supplied, nothing can be expected but trouble and expense. In fact, it is not an uncommon sight to see such a boiler with the funnel practically at a red heat, the color of which is easily visible at night. All of which proves that the combustion chamber has been transferred to the funnel, which can hardly be called a proper place for the production of steam.

There is no advantage to be gained by a large fire grate if the right proportion of smoke tubes is not provided to carry off the gases. In some cases too large a fire grate has caused explosions in the back of the furnace, which have blown the fire through the doors when the stokers have opened the doors for firing. Such conditions mean low efficiency and heavy boiler repair bills.

The writer is quite in accord with "J. S." in the matter of the proper position of fire bars and bridges. There is far more in this matter than some builders seem to imagine. As "J. S." says: "Where a boiler fails to supply the required amount of steam on a trial trip, assuming other proportions correct, in many cases all that is required is a reconstruction of the fire bars and bridges." As a proof of this, the writer had an experience some time ago with a marine boiler supplying steam to a stationary plant. Great trouble was experienced in keeping up steam; in general, the conditions were bad. The fire bars had been run clear back to the back of the combustion chamber, the grate area being 37.5 square feet. After reconstructing the fire bars, and fitting proper bridges, the writer reduced the grate area down to 20 square feet, after which the boiler steamed well, and gave excellent results. No shortage of steam has been experienced since then, and a saving of nearly one ton of coal per week has resulted from this alteration. This is only one of many cases which the writer has handled in the same manner with very great advantage and economy and compares with the practical remarks of "J. S."

As regards the matter of steam space, it is always false economy to curtail boiler dimensions. If any error is made the dimensions should be too large rather than too small. From .58 to .65 cubic feet per indicated horsepower should give fairly satisfactory results, other proportions being equal. There is no doubt but that the main trouble occasioned in marine boilers is due to the fact that the boilers are too small for the engines for which they are to supply steam. Exhausted stokers, who have spent every ounce of their energy in a mad effort to keep up steam, will bear witness to the truth of this statement, and I have no doubt that it is well known to "J. S."

No doubt, many failures of boilers to supply sufficient steam, where the boiler proportions are good, exists in the fact that the coal supplied is of a cheap quality and of low calorific value. If a designer has figured on a certain consumption of fuel per square foot of grate, and assumed that feed water is delivered to the boiler at a high temperature, knowing the rate of evaporation from an average steam coal, the builder is quite justified in rating the power of his boiler on this assumption. Inferior coal and other defects, however, may bring the power of the boiler considerably below the builder's rating. Take a marine boiler with 40 square feet of grate area. The designer knows from past experience that under ordinary conditions 18 pounds of good steam coal can be burned

per square foot of grate area, or 750 pounds per hour, and that 10 pounds of water can be evaporated from and at 212 degrees Fahrenheit per pound of coal, making 7,200 pounds of water. Assuming a compound engine, using 20 pounds of steam per horsepower, the boiler should supply steam for 360 indicated horsepower.

On the other hand, it is more often the case that a cheap coal of low calorific value is supplied, only 12 pounds of which can be burned per square foot of grate, and only 7 pounds of water can be evaporated per pound of coal. We, therefore, have 480 pounds of coal consumed and an evaporation of 3,360 pounds, supplying steam for only 168 horsepower, which is a very different state of affairs. Should the boiler be too small and require additional forcing to get the required power, the case will be practically hopeless.

Another cause of many boiler failures is that the designer has little or no say in the matter, and is thereby compelled to depart from what he knows by experience to be right. He is often supplied with the main particulars as to length and diameter, and diameter of furnaces. In some cases the heating surface is given, but in many cases it is not, and very often the designer is informed that the particulars given are binding and must be adhered to. Beyond this, he may hear nothing further until some few months later, when he may be asked to look up particulars regarding boiler No. so-and-so, as complaints have been received from the owners that the boiler is too small and does not give satisfaction. When the matter is finally investigated, it is found that the boiler would have been satisfactory if it had been 1 foot larger in diameter than the one ordered. The results, therefore, are due entirely to the owners or their representatives.

In conclusion, the price of coal has advanced so much in recent years that owners cannot, or at least think they cannot, afford to pay the price asked for good steam coal, with the result that the cheap, inferior coal is the order of the day, and many boiler failures follow as regards steaming capacity.

Some time ago it was the writer's privilege to see the Ross Schofield circulators fitted, with very satisfactory results, to a marine boiler that was very much too small for its service. Perhaps the following figures may be of interest to some of the readers of this journal.

For the four months previous to fitting the circulators the coal consumption was 144 tons. For the four months after fitting the circulators the coal consumption was 123 tons. During the four months before the circulators were fitted the vessel ran 3,848 miles, while for the four months after the circulators were fitted the mileage was 4,720, or 872 miles more on 20 tons less coal. Of course, the extra mileage is not due to the circulators, but the duty of the boat was that much more and accomplished on 20 tons less coal.

Gloucester, England. C. R. Williamson.

Instructions for Firing

Each fireman will usually declare that he is spreading his coal evenly over the fires and that there is nothing left to be desired in his way of firing. He has a peculiar twist, that he gives to each shovelful, which causes the coal to spread out into a nice even layer. He can't say just how it happens; but he does it just the same. Such is human nature when one is dealing with himself. The facts are entirely different.

After watching supposedly first-class firemen working, and after carefully examining the fires built up by them, it was easily seen that the coal was not spread evenly but that it was piled in roughly, leaving hills and hollows in the bed of burning coal. All the leveling was done with either the hoe or the devil's claw.

In order that each man might see exactly what he was accomplishing, a dummy furnace was built out of rough timber. The fire space was represented by a wooden box: the bottom representing the grate; the top, the lower rows of tubes; the sides, the firebrick walls of the furnace. The front end of the box was closed and a door (similar to a regular furnace door) provided; the back end of the box was left entirely open. The whole box was so placed in an unused fireroom that it was at the same height as one of the furnaces would be under actual conditions of firing.

Each fireman was given a chance to show his skill with this contrivance. A pile of coal was placed near the furnace door. At a signal from the instructor the fireman threw open the furnace door, rapidly shoveled the coal in (using his own individual method), then swung the door shut, the whole just as though he were firing under the most approved system. He then confidently walked around to the back of the box to see what results he had obtained in spreading the coal evenly.

The results were a surprise in nearly every case. A strong fireman usually caused at least one-half of his coal to go clear through the dummy furnace and to land on the floor plates beyond. In actual firing such work would cause about one-half of the coal used to bank up against the back wall of the furnace, where it is quite probable that it would remain, as few firemen reach in that far with a hoe. Others made a neat little pile in the center of the box bottom; a performance that would be sure to cause much smoke and loss of heat in actual practice. There were many more peculiarities, but the principal result was to show that proper firing was almost unknown in that fireroom.

The discovery of this unpleasant fact led to continued practice by all firemen in the department. If a man desired to hold his rate he had to show that he could really do his work on the fires. The results were not instantaneous, but they told in the end. Less smoke, less coal, more steady steam, and less actual work in firing were some of the results achieved by improving the fires.

In addition to working the firemen at the dummy furnace, coal passers were given a chance to partly qualify for firemen by the same means. This resulted in a new fireman actually knowing how to spread coal when he first got his rate and pay of a fireman.

Although allowances must be made for the fact that conditions in regard to heat, etc., were not the same when conducting dummy practice as they were when actually firing a steaming boiler, the results achieved fully repaid all time and money spent on the dummy furnace. If one can do a thing well under favorable conditions, he is better qualified to do it under unfavorable conditions than if he has never attempted it at all. This is the foundation upon which all such training must rest.

W. W. B.

River Terminal Conference.—A conference on River Terminals of Mississippi Valley States was held in St. Louis, Mo., on February 18 and 19. Reports were presented by delegates from those cities along the rivers in the Mississippi Valley that have made substantial progress in improving river terminals, and papers were read by prominent engineers and city officials identified with the work of providing adequate river terminal facilities. The relation of the Panama Canal to the Mississippi Valley was discussed, and the new terminals at New Orleans, St. Louis, Kansas City and other large cities described.

Marine Articles in the Engineering Press

Some Recent Developments in Marine Engines and Auxiliaries—A Discussion of the Use of Gusset Plates in Ship Construction

Recent Development of Marine Engines, Including Propulsion.—This review deals with the experience in marine engineering of the last 10 to 15 years. Starting with a consideration of the Scotch boiler, it acknowledges its great economic superiority, particularly with high pressures up to 235 pounds and the Howden type hot forced draft. It records modern requirements of boiler material tests and protests against English Board of Trade test pressure at double the working pressure. The article takes careful note of the modern superheated steam plant with its saving in coal. The watertube boiler is dealt with, giving German naval experience with one single type of bent-tube form and mercantile experience with a straight-tube type, usually in connection with steam turbines. The turbine is considered firmly established upon ships of over 20 knots speed. Difficulties of propeller revolutions and of structural turbine details are said to be more readily overcome. The modern tendency of adopting combination turbines of several impulse wheels in the high-pressure range with low-pressure reaction drums is quoted, as well as the mixed system for medium-speed ships of two piston engines exhausting into one low-pressure turbine. The growing popularity of the hydraulic transformer, as well as gear transmission, is commented upon. The oil engine receives considerable attention, pointing out that the difficulties experienced so far can be readily overcome, many being only in the auxiliaries, while cracked engine parts might, in the exposed parts, be exchangeable; lubrication difficulties could be overcome by larger bearings, better quality of oil and forced feed. The requirements of power by the auxiliaries are discussed, as well as the suitability of sea water for cooling purposes. It is noted that a great many complaints of ship owners against the oil engine are still recorded, as must be expected for a new type, which, however, is likely to be simplified and improved. A table of data of the leading recent marine oil engines is given. In conclusion, a plea is made for efforts to minimize coal-bunker trimming and the labor on sea-going vessels by installing suitable efficient machinery. 2 tables. 5,300 words.—*Zeitschrift des Vereines Deutscher Ingenieure,* August 1.

Recent Auxiliaries and Equipment for Merchant Vessels.—This article is a continuation of one previously reviewed giving a description of modern electric and steam winches for different purposes, among them being a 24 horsepower electric combined provision, coal or boat hoisting winch, as now frequently installed upon large passenger steamers. A description is also given of a 24 horsepower electric boat hoister, a steam fish net winch with a drum capacity for 700 fathoms, and a steam boat hoister, also with nigger heads only. Mention is made of the sounding machines which are now put on the market fitted with a 2½ horsepower motor, and which allows a 55-pound lead to be heaved at a rate of over 7 feet per second. Among the equipment is described the Clayton apparatus, which generates and employs sulphur-dioxide for purposes of fire extinction, disinfection and vermin extermination; further are mentioned the fire extinction systems, which employ carbonic acid gas and the automatic Grinnell sprinklers. Among the modern auxiliaries for the engine room are noted the Weir dual air pump and a twin steam ash hoist of the drum type. Further, an evaporator of the double effect type is well described, as well as a feed heater. Attention is given to modern ball and roller thrust bearings, describing two different types, both conveniently arranged in adjustable casings with oil retention. In conclusion, mention is made of the new Brouguiere marine governor, which under pitching motions of the ship opens or closes a special stop valve through the inertia action of a heavy weight, being so jointed, however, to the valve lever that rolling motions have no effect upon the valve. 45 illustrations. 2,900 words.—*Zeitschrift des Vereines Deutscher Ingenieure,* September 12 and 19.

On the Use of Plate Gussets in Shipbuilding.—This article deals with the question of whether or not gusset plates are always employed to the best advantage in ship construction. It endeavors to show that they are best employed for two cases, first when the member to be connected can be held rigidly and clamped, and second in the skeleton framing of the ship. The importance of the support of the gusset upon the rigidity or elasticity of the member is pointed out and the claim made that in many cases the gussets are only extra weight and that a simple corner angle would have done as well, treating the girder only as loosely supported. The author thinks that even the limited rivet area obtained by the latter will be satisfactory for most cases. The demand of the classification societies for gussets nearly everywhere is criticised as wasteful in the direction of weight and cost; this applies principally to gussets on watertight bulkheads. According to the deductions of the author there are two places in the ship where plate gussets are unnecessary, namely, at the half beams abreast of hatches and at the beams of the superstructure houses and decks. For the first he considers it desirable to put more strength and rigidity into the frame section at the ends of the hatch and for the latter he sees a better stiffening to be obtained from wide-spaced belt frames and beams. 3 illustrations. 2,700 words.—*Schiffbau,* December 9.

Progressive Speed Trials of Motor Boats.—By A. H. Burnand. A description of a method of making speed and power trials by motor boats by making use of data from bench tests of the motor under various conditions of speed and power, and then determining the brake horsepower of the motor on actual speed trials of the boat by measuring accurately the revolutions per minute and interpolating from the power curves obtained on bench tests. By a combination of the data thus obtained a curve of horsepowers at various speeds of the boat may be plotted. 2 illustrations. 1,300 words.—*Engineering,* November 20.

Experimental Marine-Type Engine at the South Shields Marine School.—Plans and description of a vertical open-front, four-cylinder, quadruple expansion marine steam engine supplied to the Marine School, South Shields, by Messrs. W. Sisson & Co., Ltd., engineers, Gloucester. The cylinders are 6 inches, 8½ inches, 12 inches and 16½ inches in diameter with a stroke of 12 inches. The engine is designed to take steam from the boiler at 200 pounds per square inch, and when working quadruple expansion and running at about 150 revolutions per minute the output is 60 brake horsepower. The engine will be used for experimental tests and investigations. 11 illustrations. 1,250 words.—*Engineering,* November 20.

ENGINEERING SPECIALTIES

Durable Wharf Buildings

Wharf buildings situated at tidewater demand unusually durable materials, due to the fact that they are exposed to the action of salt air and mist in addition to the ordinary action of the elements. Galvanized sheet metal would appear to be one of the most suitable materials for this construction, if it were not for the fact that galvanizing is a protection only so long as it lasts, and that at tidewater zinc galvanizing is very far from permanent, corroding away in the course of a very few years and leaving the base metal exposed to the active forces of disintegration.

Municipal Wharf, San Diego, Cal. Dimensions, 70 x 760 Feet. Roofing, No. 14 Gage Galvanized 2½ Inches Corrugated Armco; Siding, No. 22 Gage Galvanized 2½ Inches Corrugated Armco

It has been found, however, that the main cause of the rapid deterioration of modern steel is its high content of impurities, especially manganese and sulphur. It is generally agreed that if these and other impurities could be entirely eliminated an iron would be produced which would be practically rust-proof. This, of course, is impossible in practice, but a number of the leading sheet-metal manufacturers of this country are now producing iron of a very high purity, the total content of all the substances considered impurities being reduced to a very small fraction of 1 percent. While more expensive than ordinary bessemer or open-hearth steel, experience seems to justify its extensive use. A number of the largest wharf and accessory buildings completed within the past two years have been covered with "Armco" iron, made by the American Rolling Mills Company, Middletown, Ohio, which comes under the high grade of material above referred to. The illustration shows municipal pier A at Los Angeles harbor, in the construction of which "Armco" iron was extensively used.

Kreutzberg Volumetric and Velocity Meter

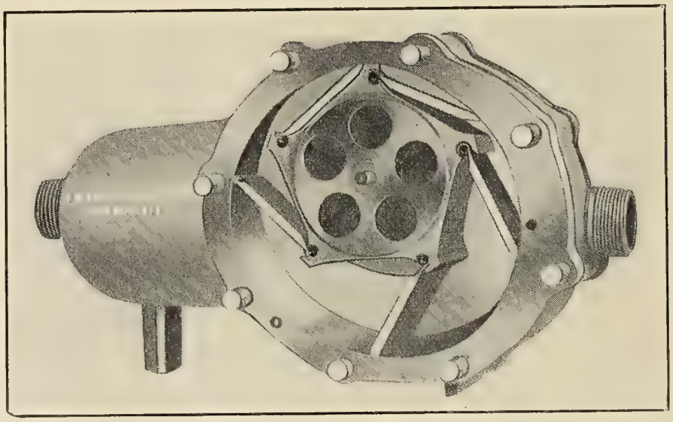
J. S. McChesney & Co., Chicago, Ill., has placed on the market a meter, known as the Kreutzberg meter, which is designed to measure accurately the volume and velocity of any fluids passing through it. The meter consists of a casing in which a drum fitted with hinged vanes is mounted eccentrically. As the drum rotates a certain definite volume of the fluid passing through the meter is confined between two adjacent vanes, and in this way the fluid is mechanically divided into sections of definite volume, so that the number of revolutions of the drum, recorded on a register, gives by direct readings the amount and velocity of the flow of the fluid.

The fluid enters the meter through a screened chamber, so that any solid matter will be removed. The fluid then passes into the meter and impinges against the vanes, causing the drum to rotate. When a vane passes the cut-off point on the inlet a section of fixed volume of the fluid is contained between the cut-off vane and the next vane ahead. The fluid is discharged as the vane passes the outlet opening at the opposite side of the meter.

It is claimed that the Kreutzberg meter makes possible the rapid and accurate measurement of commercial quantities of any fluid, such as oil, alcohol, turpentine, etc., and also gas, steam and air under high pressure. Since the function of the vanes is to divide the flow into sections, the pressure on each side is theoretically the same, and in practice differs only by the energy required to rotate the drum which in pressures greater than five pounds is negligible. The wear on the vanes is at the end, and this, it is claimed, is automatically taken up.

With compressed air and pneumatic tools in general use, the loss of air, whether through faulty tools or by line leakage, frequently assumes serious proportions. To detect this loss and accurately measure the amount of air required to secure maximum efficiency, the Kreutzberg meter has been found most useful, especially to the user of pneumatic tools seeking absolute information as to air consumption in the shop or the efficiency of tools offered for sale.

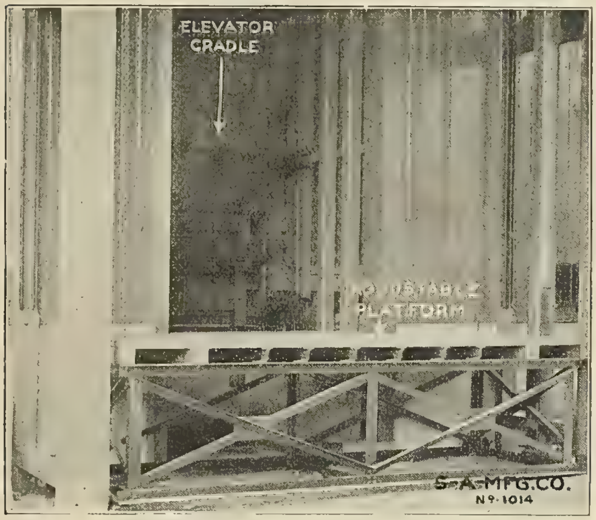
It is stated by the manufacturers that several railroads and factories are using the meter in compressed air and steam lines to determine proportions of total supply delivered to different departments, thus affording figures upon which to base operative and manufacturing costs. Comparative tests are also made as to the air consumption of a tool when new and after a period of service. In this latter case, if the consumption has increased excessively, the tool may be subject to inspection to determine where the leakage occurs and how this can be reduced so that the tool will regain its original efficiency for a longer period. Further, tools may be tested periodically and sent to the tool room for repair when excessive air consumption is required to work them at full efficiency.



Kreutzberg Meter with Side Removed, Showing Drum and Vanes

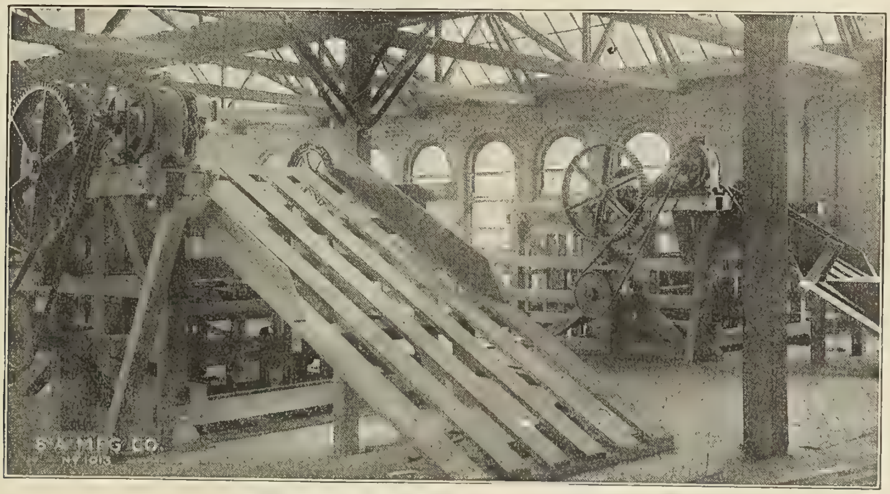
Wool Bale Elevators of the Sidney Harbour Trust

The Sydney Harbour Trust, of Sydney, Australia, has recently made a duplicate installation of elevating machinery for handling wool bales. These elevators are of the continuous type especially designed for the service and replace old hydraulic lift elevators. Since operating the new elevators it has been found that the cost of handling the wool bales has been greatly reduced, because the continuous elevators avoid the rehandling which was formerly necessary in stacking the bales on the platform of the old lift.



Cradle and Receiving Platform

The bales are delivered from larries onto the receiving platforms of the elevators. These platforms are made adjustable so that they may always be held at the level of the stacks, being lowered as the stack is reduced. The elevators are made sufficiently wide to take the bales lying down, making it unnecessary to turn the bales up on end before delivering to the cradles. At the discharge end the elevators are provided with special guides which automatically turn the bales into correct position for trucking.


Discharge End of Wool Bale Elevator

The cradles of the elevators are made up of "T" steel fingers which dovetail with similar fingers on the loading platform. The cradles are supported on special attachments carried on two strands of "S-A" combination chain. Individual motor drives are provided for each elevator, driving through silent chain and two sets of reduction gears. Automatic brakes are also provided to prevent the elevators reversing when power is suddenly shut off.

The elevators are approximately 48 feet centers and at their operating speed of 60 feet per minute are capable of elevating 280 500-pound bales per hour.

These elevators were designed by the Sydney Harbour Trust, under the direction of Mr. W. F. Adams, assistant engineer, and J. H. Groom, chief draftsman. They were manufactured by the Stephens-Adamson Manufacturing Company, of Aurora, Ill.

The New Wilson Safety Goggle

In the May, 1914, issue of INTERNATIONAL MARINE ENGINEERING was published an illustrated description of the Willson safety glasses, manufactured by T. A. Willson & Co., Inc., Reading, Pa., for protecting the eyes of chippers and men doing heavy work where they are liable to be struck by large slugs of metal. These glasses, it will be recalled, are of an extra strong construction, having a patented safety flange which extends 1/8 inch over the back of the glass to prevent broken glass going through and injuring the workman's eye. The side shields are made of strong wire screen. The temples are inside the shields and fold back of the glass.

Such heavy protection glasses, however, are unsatisfactory for grinders, machinists and men doing light work, so a short time ago the manufacturers perfected a new Willson goggle especially designed to meet the requirements of grinders and machinists. The new goggle is very light in weight and at the same time substantial enough to withstand the hardest knocks to which it would be likely to be subjected. The safety flange used in the previous heavy chippers' glasses has been eliminated, as there is no danger of the glass being broken. Protection is only necessary from flying bits of emery, dust and grit. The rim of the new goggle which replaces the flanged frame of the safety glass is amply strong. The lenses are of good quality glass. The side shields are much lighter and of finer mesh. The temples are on the outside of the shields and fold over the front of the glasses. The new goggles are supplied in a strong steel case, protecting them when carried by the men.

The manufacturers of the above specialties were awarded the grand prize at the Second International Exposition of Safety and Sanitation, held at the Grand Central Palace, New York, December 12 to 19, 1914, in acknowledgment of the merits of the Willson safety glass, the new Willson goggle and the Albex eye protector.

Buffalo Machine Guards

The Buffalo Wire Works Company, Buffalo, N. Y., has on the market wire machine guards to be placed around exposed moving parts of machinery, such as belts, flywheels, pulleys, etc. The guards are made to fit almost any

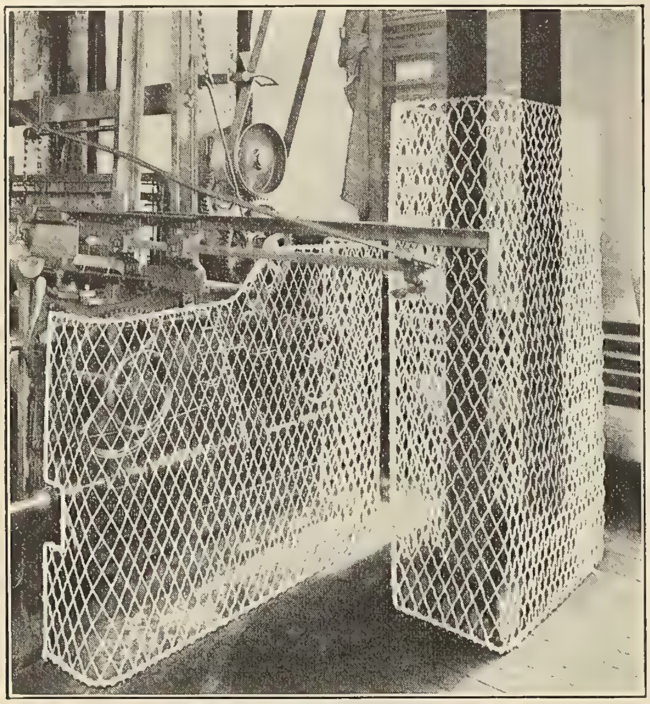


Fig. 1

arrangement of machinery. They are constructed with 1½-inch diamond mesh of No. 9, 10 or 12 gage wire with either channel iron frames (as shown in Fig. 2) or round iron frames (as shown in Fig. 1). Means are provided

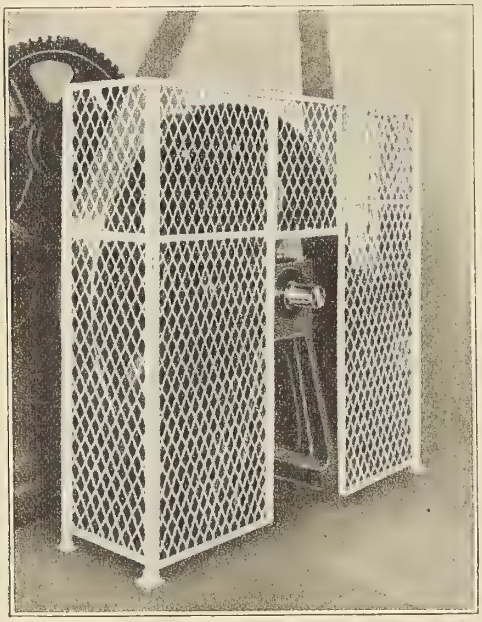


Fig. 2

for fastening the guards to the floor, or either type can be made with legs that can be fitted into holes in the floor and thereby allow the guards to be removed when necessary.

Machine guards of this type are one of the most important safety appliances that can be installed in a shop. They not only save life and limb, but also decrease insurance rates and the costs for damages from accidents.

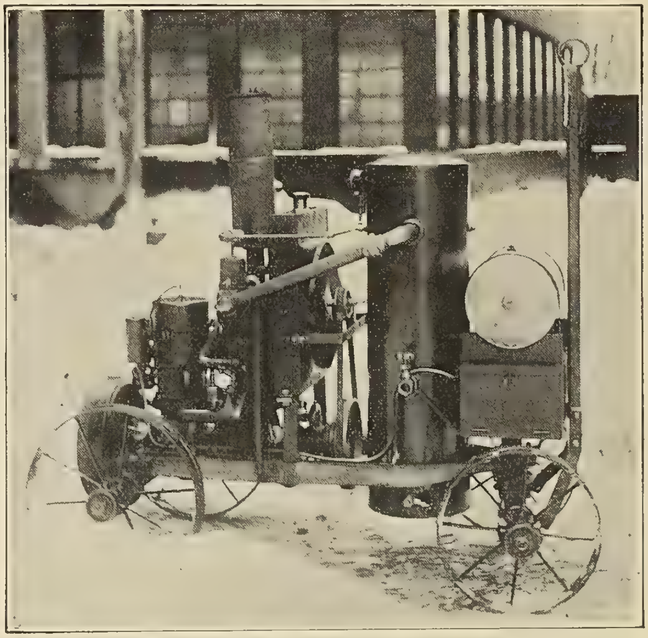
Worth Brothers-Coatesville Rolling Mill Company to Manufacture Basic Open Hearth Steel Tubes

The Worth Brothers-Coatesville Rolling Mill Company, Coatesville, Pa., which holds the unique position of being the only tube manufacturer that can supply itself with basic open hearth steel skelp for tube manufacture, has decided to take advantage of this opportunity to manufacture basic open hearth steel tubes. The value of Worth Brothers' well-known quality of locomotive boiler and firebox steel for equipment and repairs is well recognized throughout the United States. This same quality, it is claimed, will be used in making basic open hearth steel tubes.

The Coatesville Rolling Mill Company claims that for many years it has been the largest producer of charcoal iron boiler tubes, and that it will continue to maintain this position, at the same time having the distinction of being the only tube manufacturer that can supply the trade with both charcoal iron and basic open hearth steel tubes manufactured from the ore to the finished product.

A Small, Portable Air Compressor

The small gasoline (petrol) engine driven portable air compressor illustrated has been developed by the Ingersoll-Rand Company, New York, to meet the needs of the contractor doing work of a temporary character requiring compressed air in small quantities. The compressor



Gasoline-Driven Portable Air Compressor

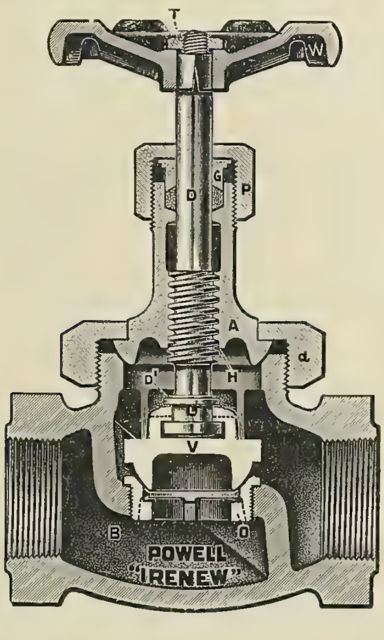
is operated by a simple single-cylinder gasoline (petrol) engine, which is coupled directly to the compressor, both pistons working on the same crank shaft. The engine is of the single-acting, two-cycle type, closely following the well-known marine designs. The air compressor, which is one of the company's standard types known as "Imperial XII," has a capacity of 45 cubic feet per minute at

a pressure of 90 pounds. It is fitted with an air unloader and the engine with a centrifugal governor. Cooling is provided for by a gear-driven pump and an automobile type radiator, with large tank capacity, serving both the compressor and engine. The radiator is assisted by a large fan.

The frame, axles and wheels are of steel, the front axle is arranged with swivel connection to the frame, permitting horizontal rotation for turning corners and sufficient vertical movement to accommodate the wheels to inequalities of the road without strain on the frame. An air receiver tested to 300 pounds water pressure and fitted with safety valve, pressure gage, necessary piping, outlets, etc., is hung at one end of the frame, and a gasoline (petrol) tank of 15 gallons capacity is supported on a large tool box, as shown in the illustration. The outfit complete weighs 1,600 pounds and is designed for hand transportation, but can be fitted with tongue and single tree if desired.

New Powell "Irenew" Valve

The William Powell Company, Cincinnati, Ohio, has placed on the market a new iron body bronze-mounted valve made in sizes of ¼ to 2 inches, inclusive, with screwed ends suitable for 150 pounds working steam pressure. The body is of cast iron with four guide ribs cast in the neck extending down close to the seat for a true axial guide to the disk while opening or closing the valve. The valve seat ring is cast of white "Powellium" bronze, a non-corrosive metal applicable to most temperatures of superheated steam, or cyanide solutions. Whenever a renewal is necessary, it is simply necessary to unscrew the seat ring by means of a flat tool of any kind engaging the lugs projecting from the inner circle. The valve disk is of the renewable horseshoe type arranged to slide over the head of the stem into a socket, permitting it to swivel freely. It is cast of white "Powellium" bronze, making it practically indestructible. For regrinding, it is simply necessary to release the bonnet by unscrewing the hexagonal end, withdraw the valve trimming and insert a pin or nail of suitable size through a drill hole to lock the disk. Fine sand or brick dust, ground glass and soap water is then applied to the disk, and it is rotated back and forth on the seat ring until a good bearing is obtained. The valves are made in globe, angle, cross and check valve patterns with screwed ends.



Personal

Arthur Simpson has been made chief engineer of the ferryboat *City of Cairo*, at Paducah, Ky.

Joseph Cody, of New Orleans, La., has been appointed third assistant engineer on the tank steamer *Alabama*.

Thomas J. Holmes, of New Orleans, La., has succeeded Charles Cornelius as assistant engineer of the steamer *Josh Cook*.

Ed. Latham has been appointed chief engineer of the river steamer *St. Louis*, Paducah, Ky., which will take up the St. Louis and Tennessee river trade about March 15.

Ward Sadler, formerly of the Johnson Iron Works, New Orleans, La., has accepted the position of chief engineer of the tank steamer *Montana*. A. O. Mildey is his first assistant.

Frank J. Sedivy is chief engineer of the Paducah & Cairo daily packet steamer *Rapids*, which has just resumed her regular trade after being laid up for several weeks on account of high water.

J. A. Narroway, formerly second engineer of the river steamer *Barrett*, is now second engineer of the river steamer *Gleaner*, which recently left Paducah, Ky., for the south with a large tow of coal.

George Murrel has been appointed chief engineer of the river packet *Alma*, which left Mobile, Ala., February 17 for Bigbee River points. H. M. Mallory is assistant engineer of this vessel.

Harry J. Thompson has resigned the position of chief engineer of the Associated Bar Pilots' tugs, New Orleans, La., to take up the furnace building business carried on for the past twenty years by the late Maurice Waller.

Anton A. Raven has retired as president of the Atlantic Mutual Insurance Company, New York, becoming chairman of its board of trustees. Mr. Raven has been connected with the Atlantic Mutual Company for sixty-three years, and was elected its president in 1897. Mr. Raven's successor is Cornelius Eldert, formerly vice-president. Walter Wood Parsons, heretofore second vice-president, has been elected vice-president, and Charles E. Fay, who was third vice-president, becomes second vice-president.

Obituary

H. Ward Leonard, inventor of the Ward Leonard system of electric drive, died of apoplexy in New York on February 18, aged 54.

Ellery S. Allen, for more than fifty years continuously employed in the coastwise steamship service, as agent and manager, died at his home in New York city on January 31, aged 78. For most of his business life Mr. Allen was connected with the Cromwell Line, operating between New Orleans and New York, which was absorbed in 1902 by the Southern Pacific Company. Mr. Allen retired from active business in 1907.

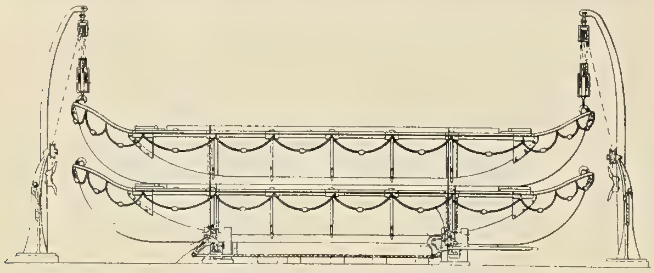
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,118,527. DEVICE FOR SECURING AND RELEASING LIFE-BOATS. HARRY W. BROADY, OF BAYSIDE, N. Y., ASSIGNOR TO WELIN MARINE EQUIPMENT COMPANY, A CORPORATION OF NEW YORK.

Claim 1.—The combination with a support for a lifeboat pivoted on the deck of a vessel, means for securing the lifeboat to such support, a link pivoted intermediate its ends and having one end connected to said



pivotal support and means for rocking said link, comprising an actuating lever pivoted to said link and fulcrumed on a suitably supported movable pivot. Nine claims.

1,118,956. GEORGE SIMSON AND JOHNSON R. GORDON, OF NEW YORK, N. Y. BILGE-TUNNEL FOR SHIPS.

Claim.—Shaft tunnels constructed in the bilges of vessels and extending from the machinery compartment to the stern tubes.

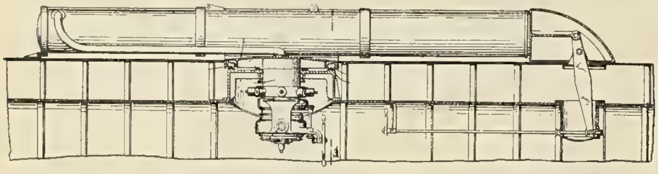
1,119,755. CHARLES D. HOLMES, OF WEST MYSTIC, CONNECTICUT. LIFE-BOAT.

Claim.—A motor boat comprising a hull formed with an outer shell and an inner shell, with air space between said shells, a cabin, an engine compartment, a cockpit between said cabin and engine compartment, the

floor of the cockpit being above the water line, and a bulkhead below the cockpit floor and separating the cabin from the engine compartment.

1,122,699. GREGORY C. DAVISON, OF QUINCY, MASSACHUSETTS. TORPEDO-LAUNCHING APPARATUS.

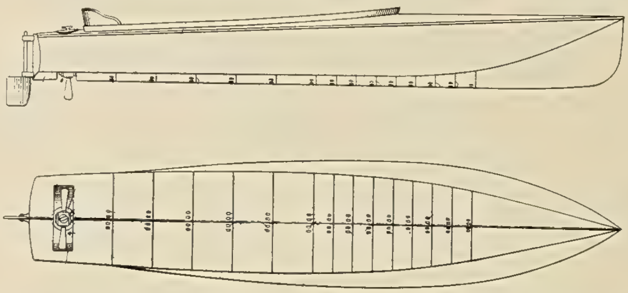
Claim 1.—The combination with a vessel, of a torpedo launching tube mounted to discharge its torpedo transversely of the direction of move-



ment of the vessel and below the surface of the water, said launching tube being free to move angularly with the torpedo during such discharge and being normally uninfluenced by the movement of the vessel through the water, whereby as the torpedo issues into the water its tendency to bind in the muzzle of the launching tube is met and suppressed by an accompanying angular movement of the tube. Six claims.

1,121,006. WILLIAM H. FAUBER, OF CHICAGO, ILLINOIS. HYDROPLANE-BOAT.

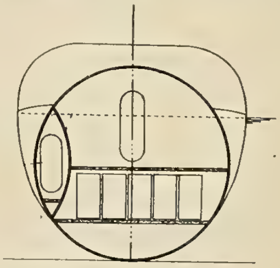
Claim 1.—A hydroplane-boat provided at each side of the center line of its bottom with a hydroplane surface which is inclined from the side wall of the hull downwardly and inwardly toward the said center or keel line, and with a transverse, rearwardly facing shoulder located in advance of the said hydroplane surface, and forming with said hydroplane



surface a transversely extending air space or channel, and also provided on the submerged parts of the sides of its hull with longitudinally continuous surfaces adapted to prevent the escape of air from the said air spaces or channels and air forcing means acting to deliver air under pressure to said air spaces or channels and adapted therein to maintain bodies of air under a pressure not less than the pressure exerted by the water against said bodies of air. Sixteen claims.

1,120,392. CESARE LAURENTI, OF SPEZIA, ITALY, ASSIGNOR TO SOCIETA ANONIMA FIAT-SAN GEORGIO, OF SPEZIA, ITALY. SUBMARINE VESSEL.

Claim 1.—A submarine vessel having a battery chamber, there being end walls for such chamber disposed transversely of the vessel and provided with doorways, and doors for closing such doorways, and a parti-



tion disposed at one side of such chamber and extending from one end wall to the other and spaced from the side of the vessel for forming a gangway laterally of the said chamber for affording communication between the portions of the vessel disposed forwardly and rearwardly of the said chamber. Two claims.

1,121,116. CHARLES A. MORRILL, OF PORTSMOUTH, NEW HAMPSHIRE. LIFE-BOAT-LAUNCHING APPARATUS.

Claim 1.—Life-boat launching-apparatus comprising in combination pivoted davits, a swinging platform hingedly attached to the ship's deck, and means connecting said platform to said davits, said platform being arranged to form a lateral extension of the deck when the boat is in loading position. Five claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

14,402/1913. IMPROVEMENTS IN MEANS FOR CLOSING AND LOCKING PORT HOLES. W. GILBERT, OF CAMBRIDGE.

According to the invention to operate or control the operation of one or a plurality of port holes from a distant point, an auxiliary link or member is connected at one end to the hand lever or to a bell cranked extension, and engaged at the other end with a controlling rod. When the controlling rod is being moved to its locking position, the respective stops engage and operate the respective auxiliary links of any port holes which are open, so as to cause the closures to be shut and locked by turning the carriers on their hinge pins, and by turning the locking rings on their carriers and remain in engagement until the controlling rod is returned to neutral position, without moving the auxiliary links of any shut port holes.

19,743/1913. APPARATUS FOR CONTROLLING FROM A DISTANCE AND FOR REGULATING THE SPEED OF THE PROPELLING TURBINES OF A SHIP. SOC. ANON. ITALIANA GIO ANSALDO & CO. OF GENOA, ITALY.

This invention comprises broadly an apparatus for controlling from a distance and for regulating automatically the propelling turbines of a ship, in which the valves both of the ahead and of the astern turbine are operated by the shaft of a differential gear one of the loose elements of which is connected to and driven by the propeller shaft, on which are mounted the turbines, whilst the other is connected to and driven by the shaft of a regulating motor, the speed of which may be caused to vary in the two directions of rotation and within wide limits, starting from zero so that the shaft of the differential gear remains at a standstill, and the valves keep up their position as long as the speed of the turbines is exactly maintained at the ratio established with the speed of the regulating motor, whilst the shaft turns in such a direction as to widen or to restrict the opening of the valves according to whether the speed of the turbines is slower or faster than that which corresponds to the speed of the regulating motor.

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Economy in the Engine Room

Those who have followed the "Economy Talks," by "Old Scotch," published in recent issues of this journal, cannot fail to realize that the market to-day is well supplied with special appliances which have an important bearing on the economy of steamship operation. It has been shown how important are many seemingly insignificant additions to an engine-room equipment, resulting in most important savings, which mean added profits to the ship owner and which should mean increased income for the engineer. This fact has been brought out in many of the letters contributed to our columns by engineers, and we hope that many others will give our readers the benefit of their experience in this line. It is quite true that any improvement which is a distinct innovation is at first accepted reluctantly by the average engineer. Reliability must be proved beyond the shadow of a doubt, and even then the investment is looked upon with suspicion. While conservatism is commendable, when the question of safety is involved, it can be carried to unpardonable lengths when investments for the sake of economy are considered. Small sums intelligently spent in equipment often mean big reductions in coal and repair bills.

The Query Department

Judging from some of the questions sent to our Department of Questions and Answers, many of our readers seem to think that it is not worth while to send in a question unless it is of a highly scientific nature. As all questions of general interest relating to shipbuilding and marine engineering will be answered in this department, provided they are submitted in good faith and the letter bears the name and address of the writer, no one should hesitate to send in questions dealing with the commonplace problems that are found troublesome in every-day work. The performance of an engine can perhaps be greatly improved, from an economical standpoint, if indicator cards taken under service conditions are carefully analyzed and defects, hitherto overlooked, are pointed out, together with the changes that should be made to overcome them Similarly, in the boiler room, losses due to poor furnace arrangements or improper methods of firing may frequently be reduced by submitting the conditions to an impartial outsider for analysis. In fact, the engine department of a modern steamship includes so many different types of power machinery that the engineer must be particularly well informed to cope with the many problems that arise, if the vessel is to be run at its best efficiency. Under such conditions the query department can be of much value to the engineer, if advantage is taken of the opportunities which it offers for aid.

The Cost of Warships

Elsewhere in this issue will be found a communication from one of our readers who takes issue with some of the statements made in our December, 1914, issue regarding the building of naval vessels in Government navy yards. There seems to be some misapprehension regarding "bids" and "estimates" from private and Government yards. So far as we are aware there is no possible way in which a navy yard can "bid" on work. A navy yard submits estimates and, if the estimates are not realized, it is not clear that anyone is responsible. To finish the work, more money must be appropriated by Congress. On the other hand, a private firm receiving a contract is limited to the contract price. If the work costs more, the contractor is responsible and is the loser. Furthermore, it is not clear what authority there is for stating that "the navy yard estimates are keeping the bids of private contractors down to somewhere near what they should be to give a reasonable profit." It is a well-known fact that many naval vessels have been built at a loss by private builders without any navy yard competition. The failure of the private shipbuilding firms referred to in our December issue, with one exception, was directly traceable to the Government work in which they engaged. Up to the time they took Government work they had no trouble.

As to the greater cost of repairs to a Government-built ship, this statement can be verified from the Navy Department records which have been brought before the naval committee of Congress. Some of these figures were published on page 205 of our May, 1914, issue. While such figures do not necessarily prove that one class of work is better than the other, nevertheless they should not be ignored, especially in the case of sister ships which have been in service for about the same length of time, when other causes than material and workmanship that may affect the cost of repairs will probably average up and may apply to a contract-built ship as well as to navy-yard-built ship.

Our correspondent's statement that "a navy-yard-built ship is constructed from the same specifications as the contract-built ship, which must be followed to the letter," is not strictly correct. As a matter of fact, the contractor

is held responsible to practically the last ten-penny nail, while in the Government-built vessel many things which are not absolutely necessary are left undone or are done in a different manner from that specified. Furthermore, it sometimes happens that the Government-built vessel is put in commission long before she is finished, and such a ship has even been known to leave a navy yard in an unfinished condition, the fact being that when the appropriation runs short it is necessary to resort to every possible means to complete the vessel in the most economical manner.

To place navy yard estimates and contractors' bids on a competitive basis is a difficult matter, for the reason that navy yard costs cannot be compared directly with the costs in a private yard. Many items which are not charged against work done in a navy yard have to be charged against the work in a private yard. For this reason it is a difficult matter in comparing contractors' bids with navy yard estimates to reconcile such items as interest on the investment in the plant, insurance, taxes, depreciation and profit, which are items of first importance in the first case. In a navy yard various items of labor are chargeable to other accounts and there is no trial trip to be paid for, which is an important item for the private builder to consider. Also, there are no penalties to be considered, either as regards contract time of construction, contract speed of the vessel, contract weights, or other contract requirements.

The question as to how any shipbuilding plant can employ and maintain a skilled and efficient force of men without work to keep them continuously employed is also perfectly applicable to the private shipyard and brings up at once the point that the few large private shipyards in this country capable of doing the work are an asset to the country, which, generally speaking, seems to be ignored. In view of the limited amount of naval work authorized each year it is necessary for the few private shipyards to have continuous, or nearly continuous, Government work if they are to keep their organization in condition to do it. Without proper organization no shipyard can do Government work satisfactorily, more especially that of the larger type, as it would take years to get an organization into proper condition for building a 32,000-ton battleship. We firmly believe that it is very important to this country to keep the few large shipyards which have made a specialty of Government work in an efficient condition.

Classing American Vessels

The comments on page 97 of our March number on the "Classification of American Ships" seem to have hit responsive chords in many directions. Of the many letters we have received regarding these comments one of the most interesting is from a president of one of the leading shipbuilding companies, who writes:

"We should be very glad to see American vessels classed in an American Society; for, if you will review the vessels classed in France you will find that the majority are subject to the Bureau Veritas; those of Germany, to the Germanic Lloyd's, and the Scandinavian countries use their societies. Here at home, as you are of course aware, we class with almost anything that comes handy. I think, however, it would be very difficult at the present time to inaugurate any classification in this country, but feel that it will undoubtedly come when we have more equitable maritime laws, and ship-owing and shipbuilding receive encouragement instead of opposition from the 'Powers That Be.'"

Nothing shows more clearly how much truth there is in this statement than a glance at the records of the different Classification Societies. The last record at hand is dated June 30, 1914, and shows the following steam vessels classed by the different socities:

American Bureau of Shipping	303
Veritas, Austro-Hungarian	352
Great Lakes Register	358
Italian Register	421
British Corporation	935
Norwegian Veritas	1,235
Germanic Lloyd's	1,925
Bureau Veritas	2,833
British Lloyd's	9,648

To analyze these figures and compare the number of steam vessels under each flag with the number of vessels classed in each country's Classification Society would be such a shock to American pride, and such a reflection upon American patriotism, that we will refrain from doing it. However, it seems to us that the subject of classing vessels should call forth positive action on the part of the Federal authorities, and that shipbuilders and ship owners should give evidence of more pride in having an American Classification Society class American-owned vessels built in American shipyards.

Big Profits in New Vessels

It seems strange to those of us who have studied the steamship situation, that more vessels are not being ordered in American shipyards. It is true that in the larger yards no deliveries can be guaranteed inside of about twenty-four months, but several of the yards have berths that are not under contract, and orders can be filled with a considerable degree of promptness. Prices may be somewhat above what they would have been six months or more ago, but it must be borne in mind that continental shipyards have undoubtedly been filled up with naval work to the entire exclusion of merchant marine work since last summer, and the same conditions have obtained in most British shipyards, so that very little merchant marine tonnage has been launched. A few of the British yards are not fitted to handle naval work, and have been turning out more or less merchant marine tonnage, but at nothing like the prices of $40 (£8 10s) per ton or thereabouts which were quoted a year ago. Indeed, recent reports would indicate that with the great increases of cost of labor and material in Great Britain, as well as on the Continent, there is little difference in the cost per ton over recent American prices.

Investigations made by one of the largest American steamship companies in the United States indicate that any difference in the first cost per ton of American-built and foreign-built vessels in the same service is more imaginary than real. A careful analysis of the operating costs of the two classes of vessels has shown that the delays in port of American-built ships for purposes of making repairs, etc., have been less than those of foreign-built vessels, and, consequently, the earnings of the American-built vessels on the investment have been greater than those of the other vessels.

With so little new tonnage under construction in the shipyards of the world, and the existing tonnage afloat decreasing at an abnormal rate—to say nothing of the interned German vessels deteriorating at the rate of about 25 percent a year—it must be very evident that those people who have vessels to sell after war ends will be able to reap very large profits. With the financial situation as it is it seems strange that people with money to invest do not fill up with orders the few yards that are able to guarantee prompt deliveries.

A Special Naval Reserve and the Merchant Marine

Now that the Congress of the United States has ended its session and the Administration Ship Purchase Bill has been laid away in its final resting place, there is opportunity to calmly discuss the old question as to the best methods of reviving the American merchant marine. The fact that the Administration made strenuous efforts to pass this bill—although along lines never before attempted by a Chief Executive to force Congress to take action contrary to the conviction of a large majority of members of both Houses—shows deep interest in this great and important subject. But all these good intentions were more than counterbalanced by the signing of the Seaman's Bill, which looks like a desperate attempt to strangle what is left of our merchant marine in the foreign trade, and to drive back under foreign flags, at the end of the war, all of the half million and more tonnage of vessels that have sought safety under the American flag.

Even then we shall have far and away the second largest merchant marine in the world, comprising over 8,000,000 tons—nearly twice that of Germany, the third on the list. But we must have ships in the foreign trade as well as the domestic, if there is any possible way of having them. Unfortunately, with this strangling grip on the shipping interests in the foreign trade, it does not seem as though any plans for reviving the merchant marine that have ever been presented to Congress in previous years can succeed. The straight subsidy plan had wonderful vitality. It was apparently killed year after year for a quarter of a century or more, but now is apparently dead for the last time. The proposed preferential duties plan has been up time and time again, but has already brought forth unofficially from foreign nations threats of reprisals if such action is enforced. All of this means not only that irritations and ill-feelings will be stirred up, but also that every commercial treaty which the government has in force must be canceled, and it is a question whether they can ever be renewed with this preferential plan included. Government ownership has now been placed alongside the subsidy and the preferential duties plan in the graveyard.

What can be done to bring about a revival of our merchant marine? The writer had presented to the President and the members of his cabinet, as well as to leading members of Congress, some months ago, a new form of bill which was favorably received by members of the Senate and the House of Representatives, but which could not be taken up seriously, as the Administration had already been drawn into the Government ownership whirlpool. This bill authorizes the United States, acting through a shipping board, to purchase a certain percentage of bonds in legitimate corporations operating ships in the foreign trade, and in this way give encouragement to an industry in somewhat the same manner that practically every industry in the country has been protected by a tariff—only another but indirect form of subscribing to bonds.

But the most important feature of this bill is the plan for organizing a Special Naval Reserve. Only American citizens can benefit by this reserve, and in consideration of masters, watch officers and seamen joining it, they are paid the difference in the American rate of wages and the foreign rate of wages from a specific fund. By carrying out this plan we would not only be building up a merchant marine in the foreign trade which could compete with other nations, but the Government would be training hundreds of men for service in all branches of the navy, in case of emergency, and at a fractional part of what their wages would be were the men regularly employed on naval vessels. The need of such trained men was made distressingly evident when the so-called Spanish war broke out. The navy simply could not find the men to properly man the many auxiliary vessels.

Leading European nations have similar reserves for both their armies and navies. Not only are practically all the men in foreign merchant marines in these reserves, but all classes of men are connected with it. Even taxicab drivers get their little yearly subsidy from their governments to be at the service of the army in case of emergency. By paying the money direct to the men who do the work, so as to bring their wages up to the American standard, as proposed in this bill, greater economic results can be obtained than by paying subsidies on the tonnage basis. It is estimated that $1,000,000 (£205,000) spent in this way will support sixteen ships of 5,000 tons a year, or eight ships of 10,000 tons; consequently, $2,000,000 (£410,000) would keep afloat twice this number of ships.

H. L. Aldrich.

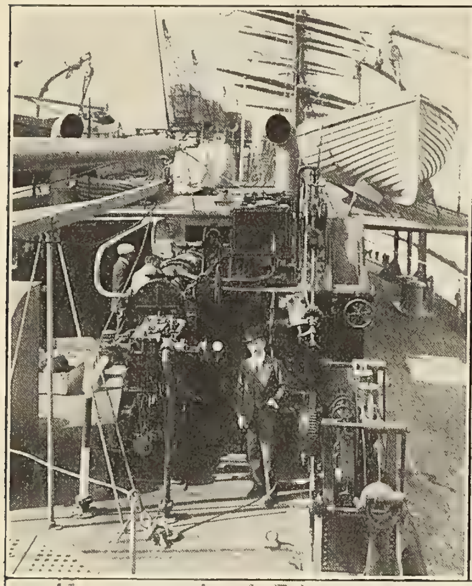
French-Built Cable Ship Edouard Jéramec

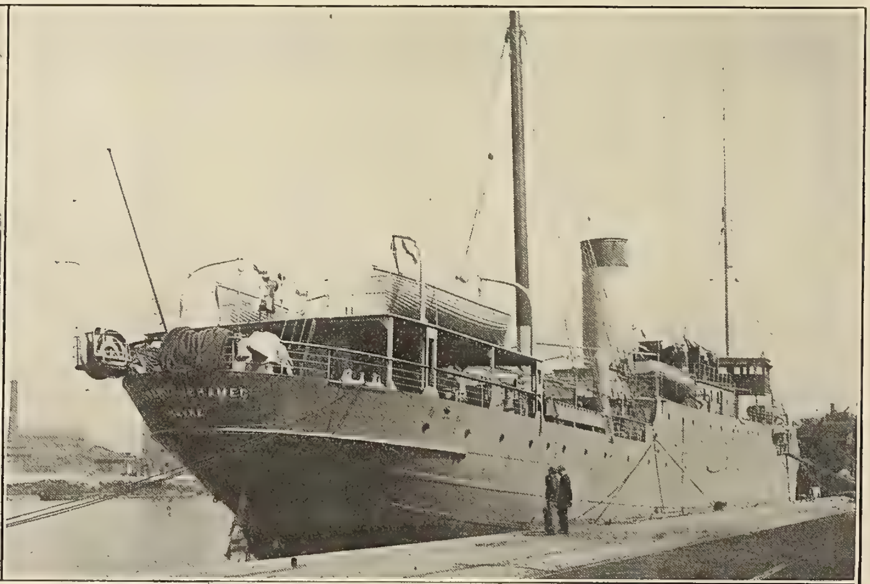
Steamship of 3,800 Tons Displacement Fitted with Special Machinery for Repairing Trans-Oceanic Cables

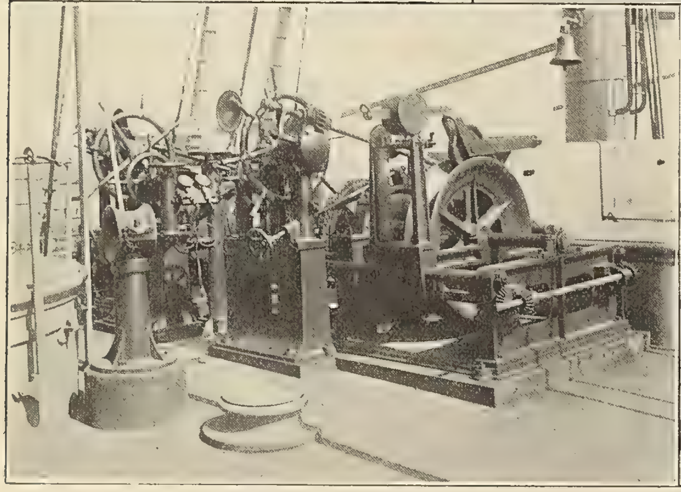
BY F. C. COLEMAN

A new twin-screw cable-repairing steamship, named *Edouard Jéramec,* built by the Société Anonyme des Forges et Chantiers de la Mediterranée, of Havre, has recently been completed to the order of the Compagnie Française des Cables Télégraphiques, of Paris. The principal dimensions of the *Edouard Jéramec* are: Length between perpendiculars, 269 feet; beam, 41 feet; depth, molded, 25.9 feet at spar deck; draft, loaded, 17.6 feet; displacement, loaded, 3,800 tons.

The vessel has water ballast tanks throughout the entire length, and there is a double bottom amidships, together with transverse bulkheads. The steel hull and spar deck with central bridge are strengthened in accordance with, and beyond, the requirements of the Bureau Veritas, in view of the fact that the vessel is required for deep-sea work and also for navigation in cold latitudes.







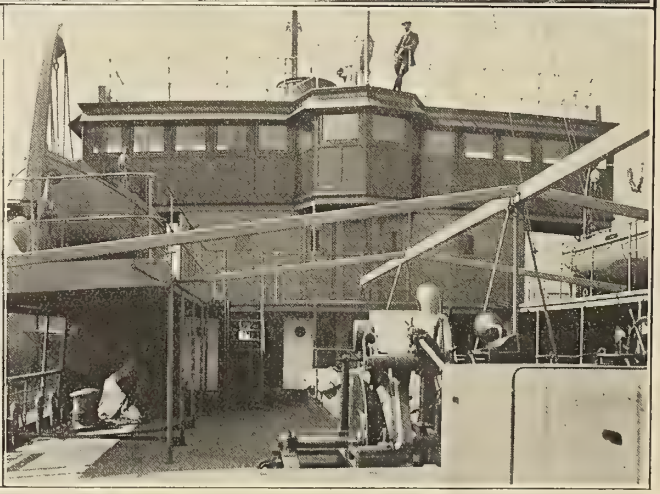


Fig. 1.—After Deck
Fig. 3.—Cable Machinery

Fig. 2.—Stern View of the *Edouard Jéramec*
Fig. 4.—Navigator's Bridge

The propelling machinery, which was built at Havre, consists of two triple-expansion engines having an aggregate of 1,900 horsepower and running at 120 revolutions per minute, giving a normal speed under ordinary load of 11 knots, with a consumption of 20 tons of coal. In view of the special nature of the work for which this vessel was built, the engines were so designed that they could be quickly changed from ahead to astern and vice versa, and on the trials, while a speed of 12½ knots was obtained, it was also possible to work the engines at only 11 revolutions per minute, corresponding to a speed of about 1 knot, and at normal speed the direction of the vessel was changed in five seconds.

There are two main boilers of the cylindrical marine type with three furnaces. The total heating surface is 4,170 square feet, and the grate area is 106.5 square feet.

Fig. 5.—Cable Repairing Steamer *Edouard Jéramec*

The boilers are fitted with Howden's forced draft and a steam ash ejector.

The three cable tanks, which have a diameter of 27.89 feet, carry a total of 800 tons of cable. The coal bunkers have a capacity of 850 tons of coal, and there is water ballast, stores, etc., for an expedition of forty days at 1,500 nautical miles from her station without any intermediate port of call.

The auxiliaries include one boiler, a donkey engine of the telemotor type, manufactured by the Atlas Works, two steam winches, one Seager refrigerating machine, one Buhring filter, submarine signaling apparatus, two electrical generating sets of 20 kilowatts and 7 kilowatts, respectively, at 110 volts, two electric ventilating fans for the ventilation of the crew's sleeping quarters, also ventilating fans in each officer's cabin; one projector and one Morse lantern, and one long-range wireless installation provided by the Compagnie Générale Radiotélégraphique, and ordinarily supplied by the ship's lighting circuit, but completed by the provision of a Renault motor of 12 to 14 horsepower in case of damage to the engine room. There has also been supplied by the firm of Grenier Lemarchand, of Havre, a heavy gasoline (petrol) motor boat of 40 horsepower capacity, complete with Welin davit gear. The boats for cable working are also slung on this type of davit.

Cable Gear

The cable gear equipment, which was supplied under contract to the shipbuilders, comprises the picking-up and paying-out machines for working the cable, with the necessary bow and stern sheaves, dynamometers, deck leads, etc., for leading the cable to the machines and overboard, together with turning-over gears, sounding machines, etc. There are two cable machines, one forward for picking-up and dealing with comparatively short lengths of cable over the bows, the other machine being placed aft for paying out long lengths of cable from the stern.

The forward machine is a double combined picking-up and paying-out machine of Messrs. Johnson & Phillips' latest pattern. This double machine is placed between the main and the spar deck, hatches being provided in the spar deck to expose the cable gear drums when working. The two parts of this double machine are capable of being worked quite independently of each other, there being two separate engines, but the machine is so arranged that should it be necessary at any time—in case of a breakdown to one engine—the engine for the port side drum may drive the starboard side drum, or vice versa, while

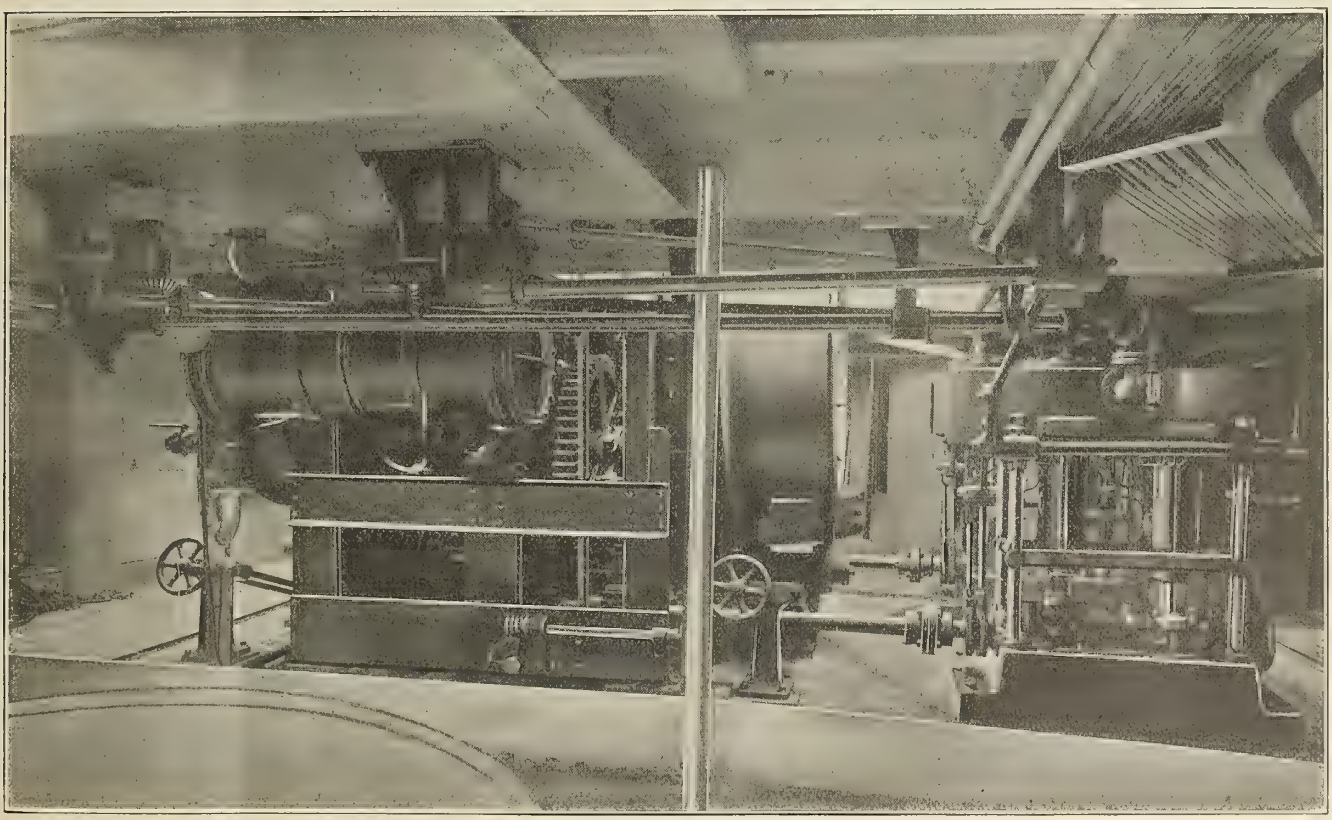


Fig. 6.—Forward Cable Machine

both engines may work on to either drum when the maximum lift is required. The two engines are placed to one side of the machine, so as to leave the fore and after ends of the gear accessible and to facilitate repairs when necessary.

The engines are twin high-pressure with 8-inch cylinders and 8-inch stroke for a working pressure of 165 pounds per square inch, and each is capable of developing 110 brake horsepower when running at a speed of 300 revolutions per minute, giving a total of 220 brake horsepower for the machine. With this power the machine is easily capable of lifting a weight of 25 tons at a rate of 1 knot per hour, while the other speeds provided admit of lifts as follows: 10 tons at 2½ knots and 6¼ tons at 4 knots per hour.

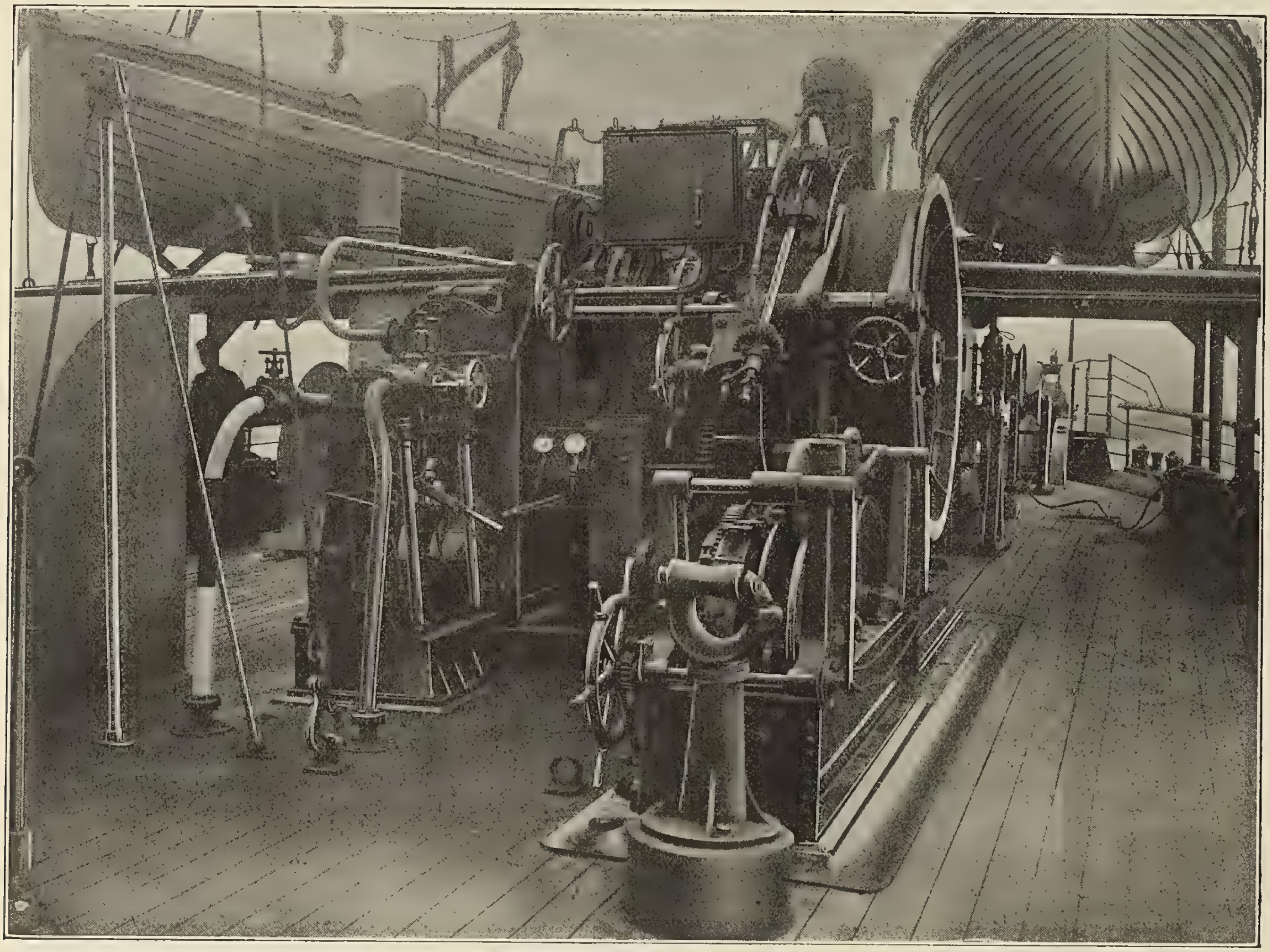


Fig. 7.—Aft Cable Machine

Brakes

The drums, which are 69.6 inches diameter by 19.3 inches wide between the flanges, are made to run loose on the shaft, in accordance with the makers' invariable practice, and they have brake rings attached to them. The brakes consist of steel straps with elm blocks encircling the brake ring, on which they are made to close by means of a double-threaded screw actuated by hand-wheel through the medium of a worm gear, giving a very fine regulation for the lighter strains, and at the same time providing enormous holding power when necessary. To the back of each back strap is fitted a water service pipe, with nozzles at intervals, to direct water between the joints of the brake blocks and right on to the face of the drum, so that the brakes may also be used for paying out.

As regards the brakes, however, the owners stipulated that one side of the cable gear should be provided with hydraulic brakes for paying out long lengths of cable, but they eventually agreed to adopt a new form of rotary oil pump brake put forward by Johnson & Phillips, Ltd., and which enabled the gear to be made more compact than with any form of hydraulic brake. These oil brakes consist of two Helo-Shaw rotary oil pumps, connected directly by double helical toothed wheels to the port or paying-out drum. Each of these pumps circulates the oil through a separate system of pipes having a controlling valve (by which the brake power is regulated) and a cooling chamber. The pumps are of the rotary type, of very simple construction, the revolving member consisting of a bronze body, bored for and fitted with six radial plungers of hardened steel, the plungers having plain hardened steel crossheads carrying gunmetal, bushed, hardened steel rollers at each side, these rollers working in a cam path in the cast steel cheeks of the fixed case.

The revolving body is actuated through its central shaft by gearing from the main drum, and the cam paths in the side cheeks of the fixed case cause the plungers to work up and down in the cylinder. The oil is drawn in and discharged through ports in the central shaft, and there is no valve gear.

The plungers are not fitted with any packing rings, but are plain bodies with a few oil grooves, and any leakage past the plungers finds its way into the casing, which

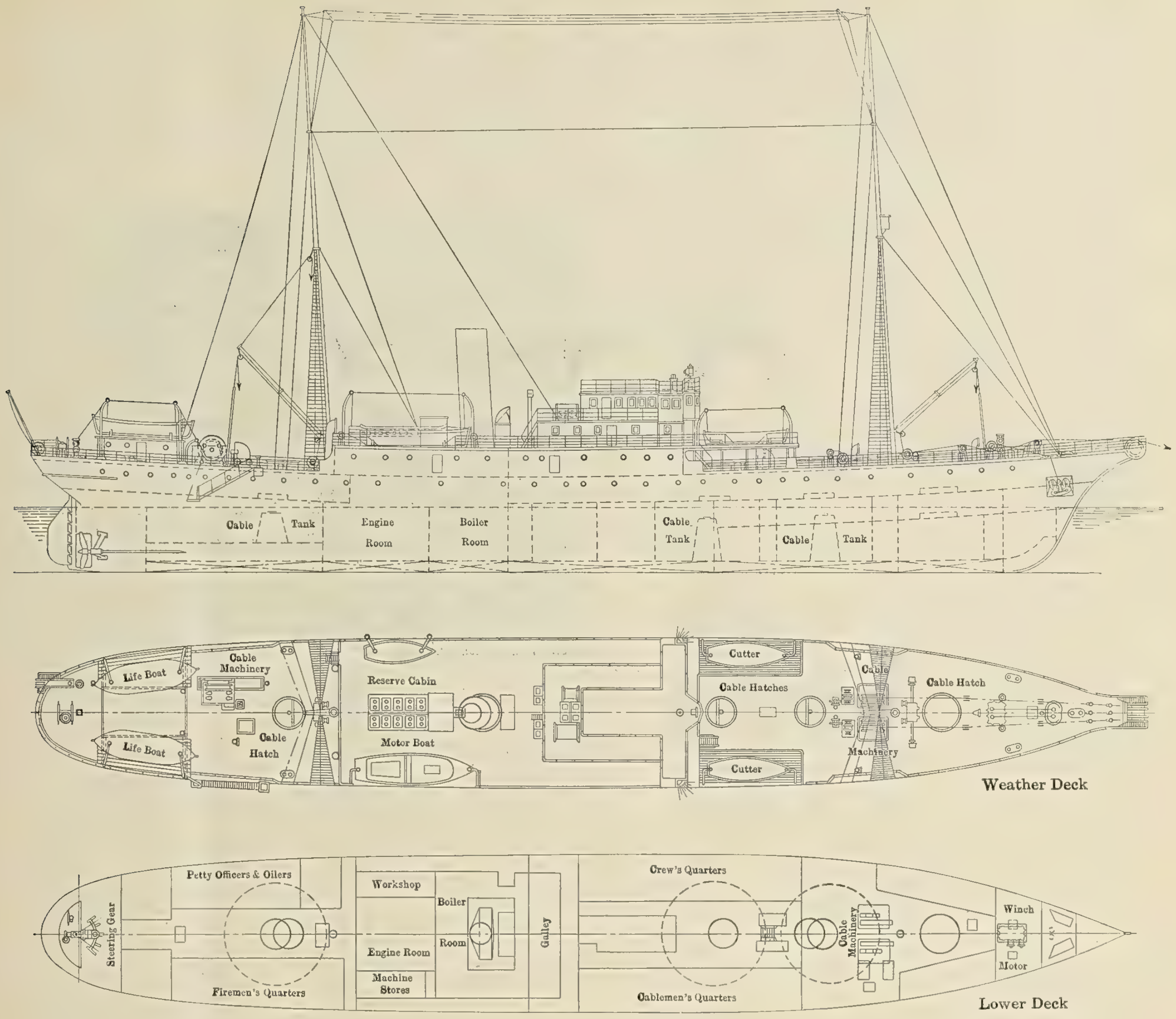


Fig. 8.—Profile and Deck Plans of Cable Repairing Steamer *Edouard Jéramec*

eventually becomes full, hence all the parts are working in oil, the conditions being practically those of forced lubrication. From the top of the casing there is an outlet pipe which carries the leakage oil back to the supply tank.

The relief valve is also connected by a pipe to the supply tank, so that any oil passing is carried back to the tank. The controlling valve is operated from the spar deck by means of a hand wheel through the medium of worm gearing, and pressure gages are fixed alongside indicating the oil pressure. The "hauling-off" and "holding-back" gear stands on the spar deck, and is driven from the geared drum by means of a chain drive, through a friction strap and "free-wheel" arrangement, in such a manner that it is driven in one direction only—viz., for picking-up—whereas it runs free for paying-out, and, therefore, when it is necessary on a picking-up job to reverse and pay out a little slack, the gear is automatic in this respect. This is a great advantage over the old system, with which it was necessary to put a clutch into and out of gear. A screw gear is also provided for traversing the haul-off sheave across the face of the drum to suit an "inside" or "outside" lead, and this can be worked while the machine is running. Screw brakes are provided on this "holding-back" gear.

Actuating Gear

Practically the whole of the actuating gear is operated from the spar deck. The brakes, two steam stop valves, and two reversing gears are all within reach from one position. The hand wheels for putting the fast, medium and slow speeds into gear and for coupling up the drums or brakes are all close at hand, as well as the levers for putting the hauling-off gear into action and all necessary regulating gear. It is only necessary to go below to couple the two engines, or to adjust the fleeting knives when the cable is being passed round the drum.

The special machine placed aft for paying out the longer lengths of cable over the stern is similar in principle to the forward machine, but it is a single machine only, with double jockey holding back gear, and it is self-contained on the spar deck, with all the controlling gear arranged at the after end of the machine. The brakes are similar to those on the forward machine, and comprise both the auxiliary hand brake as well as the rotary oil pump brake. This machine is provided with a small engine of 45 brake horsepower for the purpose of starting-up and for hauling back when necessary, and it is capable of hauling the cable under a strain of 10 tons at the rate

of ⅜ knot per hour, or under a strain of 1 ton at 3 knots per hour.

The bow sheaves and whiskers have been very neatly incorporated in the bow by the shipbuilders. There are three sheaves 4 feet 3 inches diameter over the flanges, each sheave fitted with cast iron guards which extend practically all round the flanges. Galvanized gratings and rails extend to the extremities of the sheaves. There is one sheave wheel at the stern 3 feet 3 inches diameter provided with similar arrangements as the bow gear.

Dynamometers are fitted both forward and aft to register the strain on the grappling ropes and cable when picking up, and on the cable while paying out. These dynamometers consist of a sheave carried on a slide which is free to travel up and down a vertical cylinder, the inside of which is provided with a plunger working in oil, forming a dashpot, so as to steady the movement and prevent jumping.

The cable leads comprise single and double roller leads, or bellmouths carried on pedestals, on which they can be adjusted for angle to suit the line of the cable. The cable tank hatches are fitted with bellmouth leads carried on cross girders, and the tanks are provided with crinolines which can be lowered as the cable is taken out, to prevent the kinking of the cable.

For transferring cable from one tank to another an electric hauling gear has been provided. This consists of a V-sheave with frames and suitable gearing and an electric motor of 6 brake horsepower supplied from the ship's lighting circuit. The gear is erected on a cast iron bedplate provided with runners for portability about the deck. For deep-sea sounding work an electric sounding machine is provided having a motor of 3 brake horsepower and suitable for sounding in depths up to 5,000 fathoms.

Refrigerating Plant on the First American Steamer to Bring Frozen and Chilled Meats from the Argentine

The arrival of the Barber Line steamship *Dochra* in New York recently with a cargo of frozen and chilled meat direct from the River Platte aroused a great deal of interest, as it marks the beginning of American refrigerated ships for carrying frozen and chilled meats from the Argentine. Previously this class of work has been entirely in the hands of British firms.

This installation of refrigerating machinery was completed on September 1, 1914, and on November 18 the vessel returned to New York carrying a thousand tons of beef, and in addition a large general cargo from Buenos Aires after a passage of twenty-seven days. The trip north was the first practical test given the refrigerating plant, and the beef was landed in New York in excellent condition. No. 3 lower hold was completely filled with frozen meat at a temperature of 15 degrees F., and in Nos. 2, 3 and 4 'tween decks, and in No. 3 hatch trunk, chilled meat was hung and carried at a temperature of 29 degrees F.

When it was decided to fit up the steamship *Dochra* for the carrying of frozen and chilled meat, fruit, etc., Messrs. Barber & Co., the owners, awarded the contract for supplying and installing the refrigerating machinery, brine pumps, brine piping, etc., to the York Manufacturing Company, of York, Pa., through their New York and export representatives, the Shipley Construction & Supply Company. The contract for insulating the various chambers was awarded to the Armstrong Cork & Insulating Company, of Pittsburg, Pa. Mr. Frank S. Martin, of New York, consulting engineer for the owners, superintended the installation.

The ammonia compressors are of the "York" marine duplex, horizontal, double-acting type, tandem connected to a horizontal cross-compound engine. The ammonia

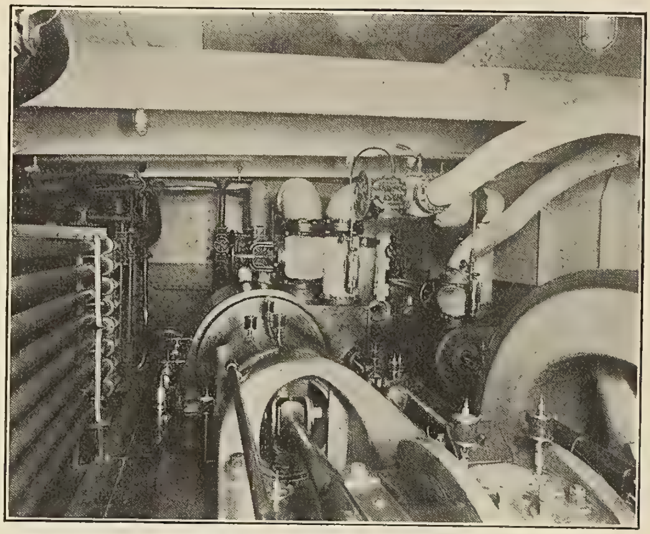


Fig. 1.—York Ammonia Compressor and Shipley Ammonia Condenser on the *Dochra*

condensers are of the double pipe counter current "Shipley" flooded style, arranged for condensing water of 85 degrees F., which is encountered by the steamer during her passage through the tropics.

The brine apparatus consists of double pipe brine coolers, a warm brine tank and two duplex steam pumps which circulate the brine through the different systems in the compartments back to the double brine return tank. Each system has its own delivery and return pipe and each return pipe has a thermometer in the brine room, so that absolute and accurate control can be maintained of the brine temperature and circulation.

All the brine coils in the chambers were made of galvanized pipe with long wrought iron return bends. The meat rails are also of galvanized pipe, covering the full surface of the ceiling, placed in between the brine coils,

Fig. 2.—'Tween Deck Refrigerated Compartment, Showing Method of Stowing Chilled Beef

each rail making a continuous pipe from end to end of the compartment in a fore and aft direction.

The insulation consists of granulated cork and cork sheets covered with waterproof felt and ⅞-inch T. & G. boards shellaced and varnished. The refrigerator doors are heavily constructed and arranged to facilitate the loading and unloading with all possible speed.

The *Dochra* is provided with a large donkey boiler and steam condenser, together with an air and circulating pump having separate steam and water connections to the ice machine, pumps, etc., making the entire refrigerating plant a separate unit. Cross-connections are also provided to the main boilers, to the main steam condensers, and to the atmosphere. The ammonia condenser circulating pump is also cross-connected on the water end with the ballast pump.

This is said to be the largest marine refrigerating apparatus that has been installed in the United States, and the test made on completion produced temperatures ranging from 5 to 14 degrees F. The whole installation has proved to be entirely satisfactory, meeting fully the requirements of the owners and of Lloyd's Register of British and Foreign Shipping.

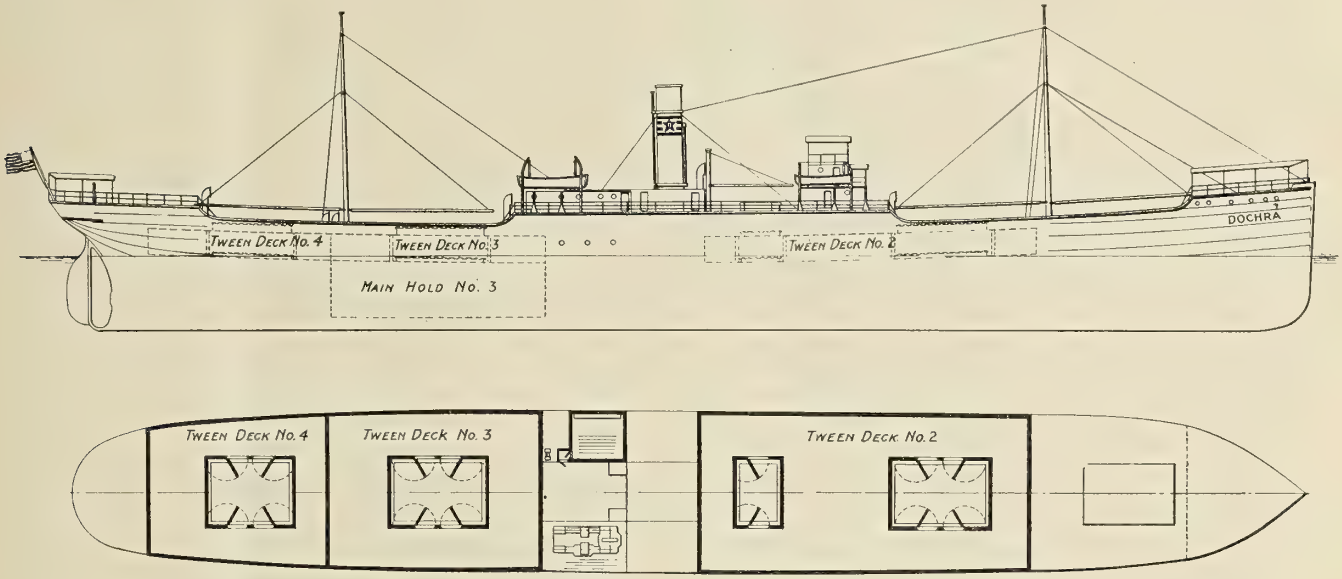


Fig. 3.—General Arrangement of the S. S. *Dochra*, Showing Location of Refrigerating Machinery and Refrigerated Compartments

Validity of Terry Turbine Patents Upheld.—An important decision is reported as rendered in the United States Court for the District of Massachusetts on March 13, 1915, in favor of the Terry Steam Turbine Company of Hartford, Conn., in its suit for infringement of patents. The decision upholds the validity of the Terry Turbine patent No. 741,385.

Performance of the Adeline Smith.—Remarkably quick deliveries of large cargoes of lumber are now being made by the lumber steamer *Adeline Smith,* which was built in 1912 by the Newport News Shipbuilding & Dry Dock Company to designs by Edward S. Hough, of San Francisco, Cal., for the C. A. Smith Lumber Company, of San Francisco. This vessel runs regularly between Marshfield, Ore., and San Francisco, a distance of 800 miles, and is now making the trip carrying from 1,600,000 to 1,700,000 feet of lumber in 97 hours, which includes the time for loading and discharging the vessel at the terminals.

New Southern Railway Coaling Pier at Charleston, S. C.

The new coal-handling plant being built by the Wellman-Seaver-Morgan Company, Cleveland, Ohio, for the Southern Railway terminal at Charleston, S. C., comprises a novel arrangement for putting coal on board ship after taking it from railroad cars by a car dumper. The dumper itself is of the well-known type used at the recently constructed coal piers at Norfolk, excepting that it is mounted on wheels and will be moved by power along the dock with the coal-loading tower. This tower provides a means of loading coal directly from the car dumper to the ship without the necessity of elevating the coal to the top of a stationary coal pier, as has generally been the custom. In other words, machinery is introduced to take the place of gravity loading.

It is expected that its results will be fully equivalent in speed of loading per unit, and that the coal will be handled much more directly and the breakage thereby reduced to a minimum. The handling of fragile coals in carload lots without breakage is a very desirable feature, and one of the points carefully considered by the Southern Railway Company in designing this pier.

General Arrangement

The plant consists essentially of a movable loading tower and a movable car dumper, mounted on tracks located on the coal pier. The tracks for the loading tower are located on the top of the pier. The car dumper is carried on a steel trestle and is designed to travel lengthwise of the dock a distance of approximately 300 feet. This trestle is of sufficient height to elevate the rails of the car dumper approximately 17 feet 8 inches above the top of the dock.

The loading towers are designed to travel along the dock a distance of 300 feet opposite to the car dumper trestle. The yard tracks for the road cars will be carried on trestles, which will form a continuation of the car dumper trestle, and in operation the loaded cars will be brought from the storage yard to the car dumper by means of a yard locomotive. The locomotive will spot the loaded cars on the cradle of the car dumper, which has first been placed in a position opposite the loading tower. The car dumper will rotate the car, discharging the contents into

a receiving hopper on the loading tower, and this receiving hopper will, in turn, discharge the coal onto a steel flight conveyor carried on a boom attached to the tower. This conveyor will transfer the coal to its outer end, which terminates in a telescopic chute, extending through the hatch opening into the cargo hold. The chute terminates at its lower end in a rotating trimmer, which can be revolved to any position for discharging coal, as desired. The telescopic chute is also capable of being swung athwartships in order to discharge the coal to the sides of the hold.

The car dumper is capable of handling thirty cars per hour, and is designed to discharge coal from any type or size of open top cars in present use. The loading tower is capable of maintaining the capacity of the car dumper.

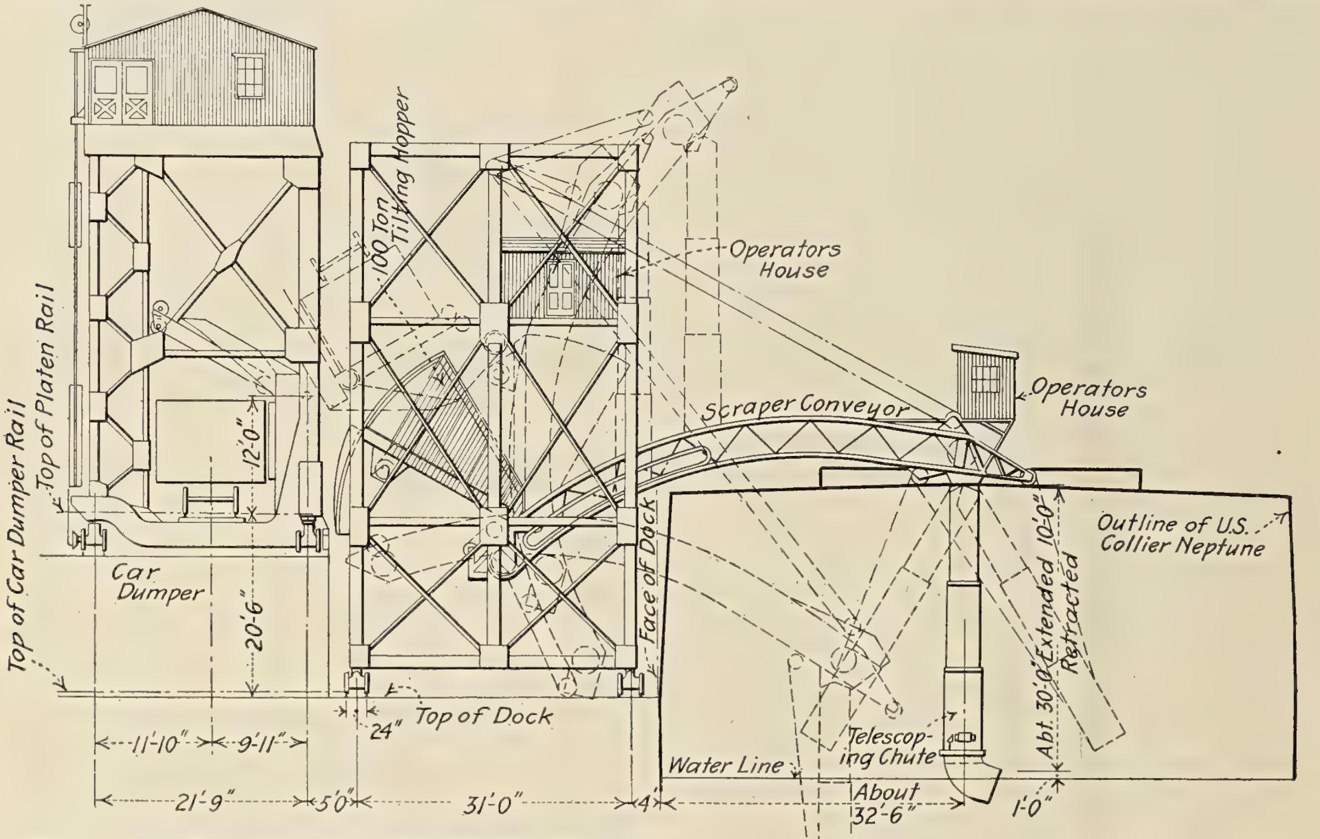


Fig. 1.—General Arrangement of Coal-Handling Plant at Southern Railway Pier, Charleston, S. C.

Movable Car Dumper

The movable car dumper is of the Hulett type, which consists of a steel framework carrying operating machinery in a house at the top of the machine. Ropes from winding drums, which are provided with the necessary gearing to connect them to the motors, are connected to the rotating cradle upon which the car is placed for dumping. These motors are under control of the operator, whose cab is located at the incoming end of the car dumper, where he may have a clear view of the work.

The rotating cradle is provided with clamps for securing the car in position on the cradle during the motion of rotation. These clamps are automatically adjustable to different sizes of cars and are operated by counterweights which travel in guides at the rear side of the framework. Their action is entirely automatic in every respect, and they require no attention from the operator.

Each end of the car dumper framework is provided with an incline approach up which the cars are pushed by the yard locomotive when being placed on the car dumper cradle. The discharge end of the car dumper is provided with a similar incline down which the cars run after being dumped and pushed out of the cradle. The points of these approaches are provided with flanges which keep them in accurate alinement with the tracks for the road cars. After a car has been dumped it is displaced by the incoming loaded car and runs down the discharge track to a switchback and thence to the empty storage yard.

The car dumper is mounted on six 4-wheel equalized trucks, designed to travel on four runway rails arranged in pairs 24 inches center to center, the front and back runway being spaced 21 feet 9 inches centers. Four of these trucks are provided with gears which are connected to the travel motor, located in the house at the top of the framework.

This machine is electrically operated throughout and is provided with all modern safety devices. The cradle is rotated by means of two motors of 200 horsepower each and the machine is traveled by means of one 100 horsepower motor. All controllers are of the magnetic switch type, and those for the cradle motors are provided with dynamic braking attachment for controlling the lowering of the cradle after dumping cars.

Loading Tower

The loading tower, which is designed to travel along runways between the car dumper and the face of the pier, consists of the steel framework mounted on trucks and provided with a hopper at the rear for receiving coal as it is dumped out of the cars by the car dumper. This hopper is of sufficient size to receive a full carload of coal and is arranged at the forward end so that it is possible to raise or lower the rear end to receive the coal. When the coal is received in this hopper, the flow from

the hopper to the conveyor is regulated by raising or lowering the back of the hopper, thus allowing the coal to be discharged onto the conveyor, as desired.

The conveyor is carried on a hinged boom supported in the forward portion of the tower framework. This boom is arranged so that it may be raised or lowered by means of ropes attached to the outer end and to the top of the tower. When discharging into boats the outer end of the boom is lowered to the proper position so that the telescopic chute extends through the hatch opening. In the extended position this boom is of sufficient length so that the telescopic chute is approximately 36 feet 6 inches forward of the front runway of the tower. The rear end of the boom is so designed, however, that the boom may be retracted in order to provide a shorter reach when discharging coal into boats of small beam.

This makes a very flexible arrangement, as it is possible to extend and elevate the boom to discharge coal into boats of large beam with high hatches, or it may be lowered and retracted to discharge into boats of small beam with low hatches, the result in each case being that the coal is not elevated beyond the requisite point to discharge through the hatch opening and consequently excessive drop is avoided. When out of service the boom is drawn up and the telescopic chute folded in such a way as to provide clearance for the rigging of ships lying alongside the pier, also to provide clearance if necessary when moving the machine from one hatch to another.

This machine is electrically operated throughout and the motions are controlled by two operators, one located at the outer end of the boom, who controls the scraper, telescopic chute and trimmer, and another operator located on the tower, who controls the hoisting or lowering of the boom, the tilting of the receiving hopper and the moving of the machine along the pier.

The boom hoist and hopper hoist are operated by one 100 horsepower motor, the gearing being provided with clutches to engage either function. The boom retracting and tower moving motion are controlled by one 65 horsepower motor. These motors are located in a machinery house on the tower framework. The conveyor is operated by an independent motor which is mounted on the boom and connected to the sprockets at the outer end of the boom. The conveyor consists of two heavy roller link chains, carrying steel flights which are approximately 2 feet wide by 8 feet long. These flights are spaced 3 feet apart on the chains and are arranged to slide the coal through a steel trough on the bottom at a speed of approximately 150 feet per minute.

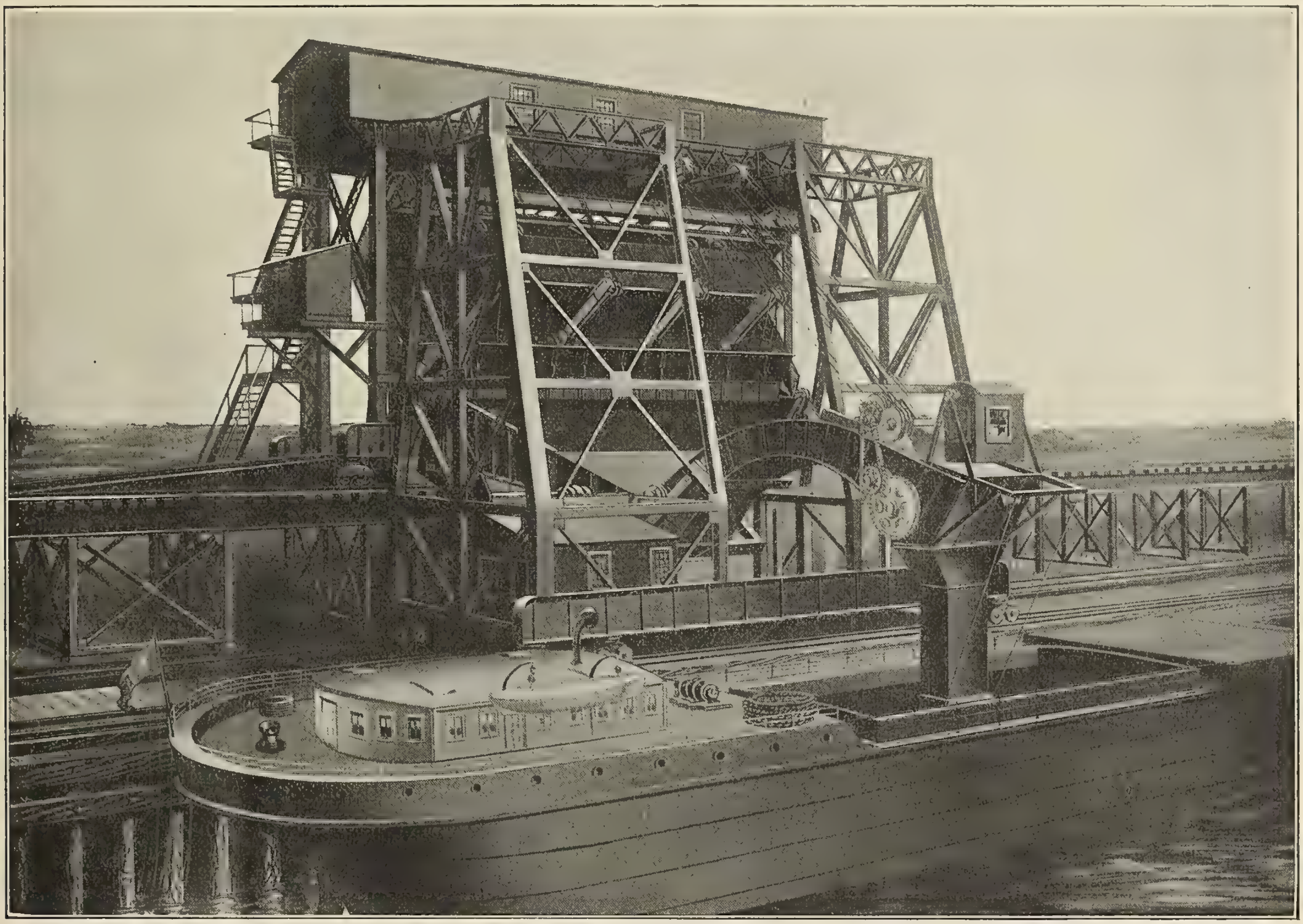


Fig. 2.—View of Southern Railway Coal-Handling Plant Sketched from General Plans

The telescopic chute at the end of the boom is raised and lowered or swung athwartships by means of ropes operated by a 25 horsepower motor, located at the end of the boom. This telescopic chute is made so that it can be extended full length when discharging the first coal into the hold and as the height of the coal increases the chute may be drawn up and telescoped so as to minimize the drop of coal as it is discharged into the cargo hold.

The loading tower is mounted upon trucks of a type similar to those used under the moving car dumper. Four of these trucks will be provided with moving gears for traveling the machine along the pier. When trimming cargo the coal car will be dumped into the tilting hopper and the coal discharged to the conveyor under control, at such speed as is required for trimming.

Construction of the Welland Ship Canal

Forging a New Link in the Navigation of the Great Lakes —The New Canal Between Lake Erie and Lake Ontario

BY W. A. CRAICK

An undertaking which will have an important bearing on the navigation of the Great Lakes of America is at present under way in the neighborhood of the Niagara River. The project embraces the construction of a ship canal of large capacity to unite the waters of Lake Ontario with those of Lake Erie and overcome the obstacle to navigation interposed by the famous cataract at Niagara. The work has been undertaken as a government enterprise by the Dominion of Canada, and it is being prosecuted at an estimated cost of $50,000,000 (£10,250,000). In point of size and in the nature of the engineering difficulties to be surmounted, the project stands second only in importance to the great canal at the Isthmus of Panama itself.

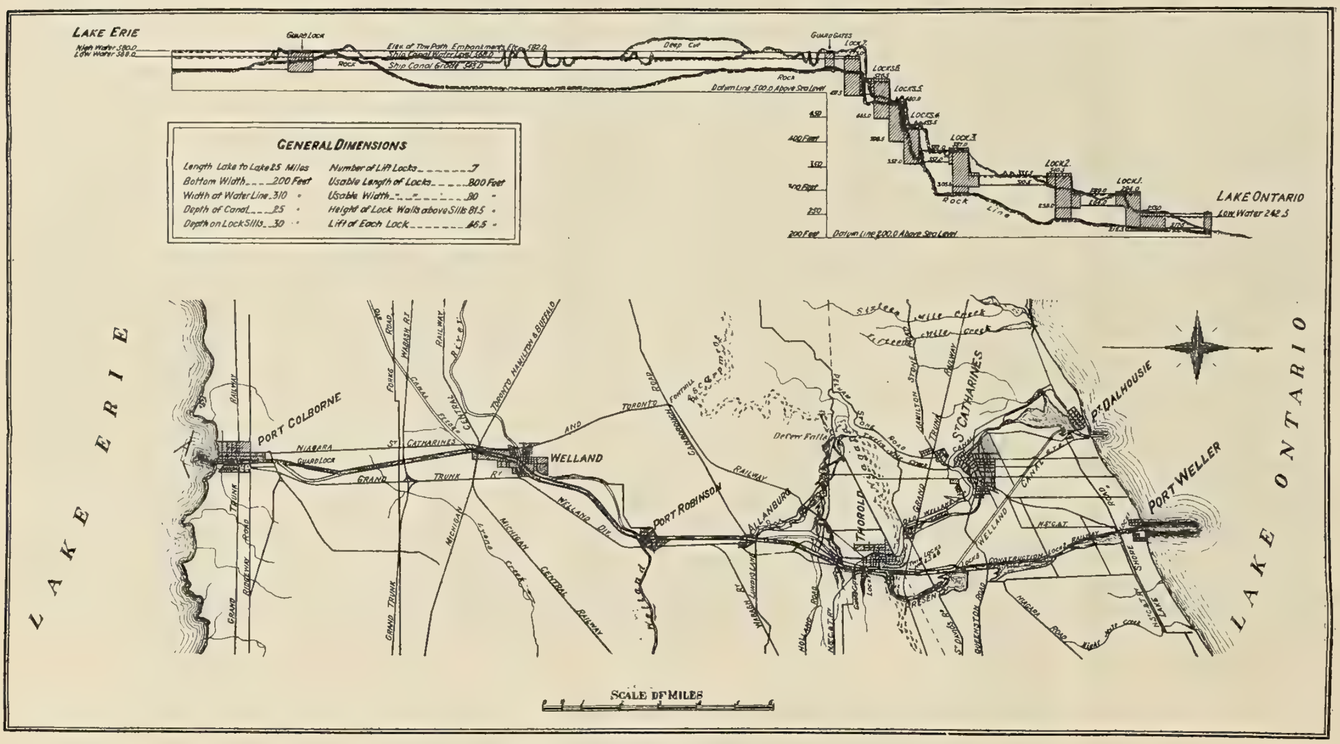


Fig. 1.—Plan and Elevation of New Welland Ship Canal

The canal now under construction is in reality the fourth Welland canal. The first was completed in 1833 and was at best but a small and insignificant piece of work. The locks, forty in number, were built of wood, their dimensions being 100 by 22 feet, with eight feet of water on the sills.

The first canal was under private ownership, but in 1841 it was acquired by the Canadian Government, which at once began to enlarge it. The work required twelve years for completion, but at the end of that time both the channel and the locks of the original canal were fully doubled in capacity. The length of the main canal was then 27½ miles, on which there were 27 locks and the minimum depth of water was 10 feet, with a bottom width of 50 feet.

In 1872, when plans for a second enlargement of the canal were submitted to the Government, it was estimated that from one-half to three-fourths of the shipping on the upper lakes was prevented by reason of the smallness of the canal from descending to Lake Ontario. The third and present canal, opened in 1887, remedied this state of affairs for the time being. The old route was discarded from Lake Ontario to the escarpment, and in its place a new and more direct route was surveyed. The prism of the canal was made 100 feet wide at the bottom and its length was reduced from 27½ to 26¾ miles. The locks, twenty-six in number, were made uniform in size, being 270 feet long, 45 feet wide, with a minimum depth of 14 feet.

While the rate of increase of traffic through the Welland Canal until recently has been comparatively slow, nevertheless in 1912 it reached 2,851,915 tons. During the same year, however, the combined freight tonnage through the American and Canadian canals at the Soo was nearly forty times as much. The deduction most easily made from these figures is that the comparative smallness of the Welland Canal, prohibiting the passage of many of the larger ships used in upper lake service, has kept down the possible tonnage through the canal.

The New Ship Canal

The necessity for bringing the Welland Canal up to the standard of the Soo canals and thereby providing uniform accommodation for ships from the head of the Great Lakes to Lake Ontario, was impressed on the Government of Canada quite early in the present century. Surveys were begun several years ago and carried to completion in 1911. Preparations of contract plans were made the following year, and in 1913 tenders were let for certain sections of the work and actual operations were be-

gun. The present year has seen a substantial start made with the undertaking, which, under present financial conditions, will probably take seven or eight years to complete.

John L. Weller, who had been superintendent of the old canal, was appointed engineer-in-charge of the new ship canal.

The new canal follows the course of the old canal from Lake Erie to Allanburg about half-way across the Peninsula, and just above the summit of the Niagara escarpment. From Allanburg an entirely new cutting is being made, crossing the present canal twice and entering Lake Ontario at the mouth of the Ten Mile Creek, three miles to the east of the old outlet at Port Dalhousie.

The Proposed Locks

The spectacular feature of the new ship canal will be the locks. At present there are twenty-six of them overcoming a rise in level between the two lakes of 325½ feet. This number will be reduced in the new canal to seven, each with a lift of 46½ feet. Of the seven, three are double locks, permitting ships to pass each other, one going up and the other going down. Locks Nos. 1, 2 and 3 bring the level of the canal up to that at the base of the escarpment, Nos. 4, 5 and 6 arranged in flight, lift it to the top of the hill, and No. 7, a short distance beyond, carries the level to that of Lake Erie.

The dimensions of the locks are to be 800 feet in length by 80 feet in width in the clear, and with 30 feet of water over the mitre sills at extreme low stages on the lakes. The lock walls are to stand 82 feet high above the top of the gate sills, and, including the necessary foundation work required below this level, two of the locks will have walls 100 feet high. Just by way of comparison and to show that the Welland Canal will not fall very far short of the Panama Canal as a notable engineering work, the dimensions of the locks at Panama may be interpolated at this point. They are 1,000 feet long by 110 feet wide, with a minimum depth of water over the sills of 41⅓ feet.

A particularly interesting feature in the case of the Welland locks is the gates. Hitherto lock gates have been invariably of the double-leaf type, hinging at either side and mitering in the center when closed. On the Welland Canal an attempt will be made to demonstrate the superiority of the single-leaf type of gate. These will hinge at one side and will rest when closed in a notch cut in the opposite wall, a single leaf thus spanning the whole width of the lock chamber. These gates will not sit at right angles to the walls, but will close obliquely, an addition of three feet in the length of the gate over the width of the lock bringing the point of contact 23 feet down the lock wall. The gates will be constructed of steel and the larger ones at the foot of each lock will measure 83 feet in height by 88 feet in length, and will weigh about 1,100 tons. Compared with these huge structures, the largest gates at Panama are dwarfed.

Water for filling the locks will in each instance be drawn from a regulating basin, situated beside or above the lock. This method of drawing water from a side pond instead of directly from the canal above avoids the formation of objectionable currents and surges in the channel and locks, which are a danger to navigation and a serious corroding influence on the earthen banks as well. The regulating basins vary in size.

By means of a system of valves and culverts of large dimensions in the lock walls, it will be possible to fill the chambers in eight minutes. This will reduce the time of passage through the canal, as compared with the time through the present canal, very materially. It now takes ships from twelve to eighteen hours to pass from lake to lake. In the new canal the same ships will be able to run through in from six to eight hours. What this means in a trip from Lake Ontario to Lake Superior in the limited period of lake navigation is easily seen.

Part of the saving of time, it is true, is to be accounted for by a reduction in the length of the canal. The new route, being more direct, cuts off fully a mile and a half from the old route. It is approximately twenty-five miles long or just one-half the length of the Panama Canal. For the present the canal reaches are to be excavated to a depth of 25 feet, but eventually this will be increased to 30 feet, all the permanent structures being built to that standard. The width at the bottom of the channel is to be 200 feet, as compared with 300 feet in the case of the Panama Canal.

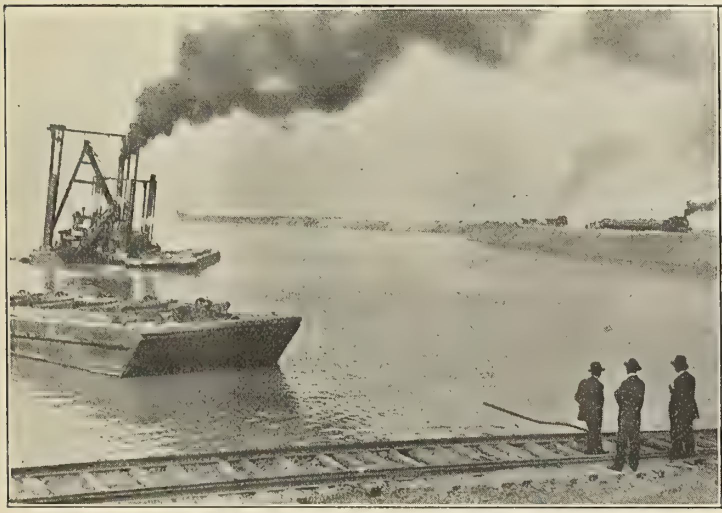


Fig. 2.—View from Inner End of Port Weller Harbor, Showing Pier and Embankments

Fig. 3.—Lake Ontario Outlet of Canal. Harbor Being Dredged to Uniform Depth of 25 Feet

Interesting Features of the Work

At the Lake Ontario end of the canal it has been found necessary to build a complete new harbor, since there was absolutely no accommodation for ships at this point. Work on this particular feature has been carried on vigorously during the past year. The outer entrance piers are to be placed a mile and a half from shore, where the

depth of the water is 30 feet. From the shore line of the lake to these piers an embankment 500 feet in width will be formed on either side of the channel, protected near the shore end by reinforced concrete cribs with concrete superstructure, alongside which vessels may lie. The whole space between the embankments is being dredged to a depth of 25 feet.

Above Allanburg, it is scarcely necessary to say, by widening and deepening the existing channel, the remaining portion of the canal will be brought to the standard of the new section. Some enlarging work will be necessary at Port Colborne, the entrance to the canal on Lake Erie. To secure quiet water in the harbor during storms, which is not the case now, a new spur, consisting of an immense rubble mound of stone from the excavations to the north, will be added to the western breakwater. It will terminate in a timber and concrete head-block, located some 2,000 feet farther out in the lake than the end of the breakwater. Here again, as at Port Weller on Lake Ontario, the harbor will be dredged to the 25-foot depth for the present.

Work on sections 1, 2, 3 and 5 of the nine sections into which the canal has been divided has been prosecuted up to the present time. These embrace the greater part of the northern half of the canal and include all the most difficult problems to be met with in construction. Chief among these have been the presence of two steam railways right in the path of the canal. One of them crosses the canal at the foot of Lock No. 4. The other runs along for a considerable distance on the very line of the waterway. In the former instance a temporary deviation is being arranged until the construction work is completed. In the latter a permanent deviation, calling for a deep cut through the corner of a hill, has been necessary, work that has cost in the neighborhood of $100,000 (£20,500).

Apart from these obstacles, however, there have been no very serious difficulties encountered so far. The only piece of permanent work yet to be noted along the route is the retaining wall that will extend from the harbor at Port Weller to the entrance of Lock No. 1. This wall is being built of steel framework, of the shape of right-angled triangles standing with their right angles at the base on the inside of the canal prism. They are reinforced with steel rods and filled in with concrete, forming a series of huge pockets into which earth and stone is packed. This method of construction is claimed to be as solid and more economical than all concrete.

The estimated cost of the Welland Ship Canal is placed at $50,000,000 (£10,250,000). This sum may be compared with the total cost of the three canals that preceded it, amounting to $29,250,951.01 (£6,000,000) on March 31, 1913. That is to say, the new canal will require an expenditure of capital amounting to two-thirds as much again as all that has been spent on the route already.

While the new canal will harmonize with the Soo canals and will give access to Lake Ontario to practically every ship now plying on the waters of the Upper Lakes, the route to the Atlantic will not be fully open until the canals along the St. Lawrence River are correspondingly enlarged. At present these canals—the Lachine, the Soulanges, the Cornwall and the Williamsburg—have been built to a 14-foot standard with locks 270 by 45 feet. In one or two instances locks 800 feet in length have been substituted, but the entire system will have to be gone over before it conforms with the Soo canals and the new Welland Ship Canal. When this day comes it will be possible for big ocean-going vessels to sail through to the head of the Great Lakes, gaining access thereby to the very center of the continent.

Stability of Vessels as Affected by Damage Due to Collision*

BY WILLIAM GATEWOOD

Stability is a subject which should receive consideration before the dimensions of a vessel are settled. The height above base line of the initial metacenter can be determined, with a fair degree of accuracy, by the use of coefficients. A convenient formula is

$$\text{Metacenter above base} = aH + c\frac{B^2}{H}.$$

In this formula H represents the draft and B the beam of the vessel; aH is the height of the center of buoyancy above base and $c\frac{B^2}{H}$ is the height of the metacenter above the center of buoyancy. For coastwise passenger and freight steamers of modern design having fine load waterline forward and full midship section, the coefficient a will vary between .57 and .54, depending on coefficient of fineness and exact shape of lines, and decreasing for the same vessel about .01 as the draft increases from 12 feet to 24 feet. For the same type of vessel, the coefficient c will vary between .078 and .082, depending on the exact shape of the load waterline and the fineness of the vessel. For the older vessels, with considerable deadrise and with V-shaped lines forward, both coefficients will be found to be greater. If they had not taught that increase in beam does not, *ipso facto,* imply increased resistance to motion, the model tanks could be blamed for a reduction in metacentric height on passenger steamers, because they are responsible for small deadrise and for fine load waterlines forward on vessels which are designed to obtain a good speed on small horsepower.

The determination of the height of the center of gravity above base cannot be approximated so readily. The vessel, as completed and loaded, can be considered as composed of six items:

1. The hull and fittings below the highest continuous deck.
2. The hull and fittings above the highest continuous deck.
3. The machinery.
4. The fuel and water.
5. The passengers, crew and stores.
6. The cargo.

In the preliminary stages of the design, an approximation of the weight and vertical center of gravity of each of these items may be made, and the results combined, in order to get an approximate figure for the height of the center of gravity of the loaded vessel. An inclining experiment made on the vessel when completed will serve to eliminate uncertainty as to some of the items, generally the first three. The last three items are variable quantities, and must be figured, at best. It has been proposed to determine the metacentric height of vessels before each voyage by inclining them as soon as the cargo is on board. Experience in inclining vessels at a shipyard indicates that the results would not be likely to be reliable, as the readings are affected so greatly by loose water and moving people. Greater accuracy is likely to be obtained by determining beforehand how much weight of cargo is to be stowed in each division of the vessel in order that the center of gravity of the cargo may not exceed a certain

* A paper read before the Society of Naval Architects and Marine Engineers, New York, December, 1914.

height above base, considered desirable in order to obtain a predetermined minimum metacentric height under the most unfavorable conditions of bunkers likely to occur on the voyage.

This leads up to the question: What is the minimum metacentric height for any vessel consistent with safety?

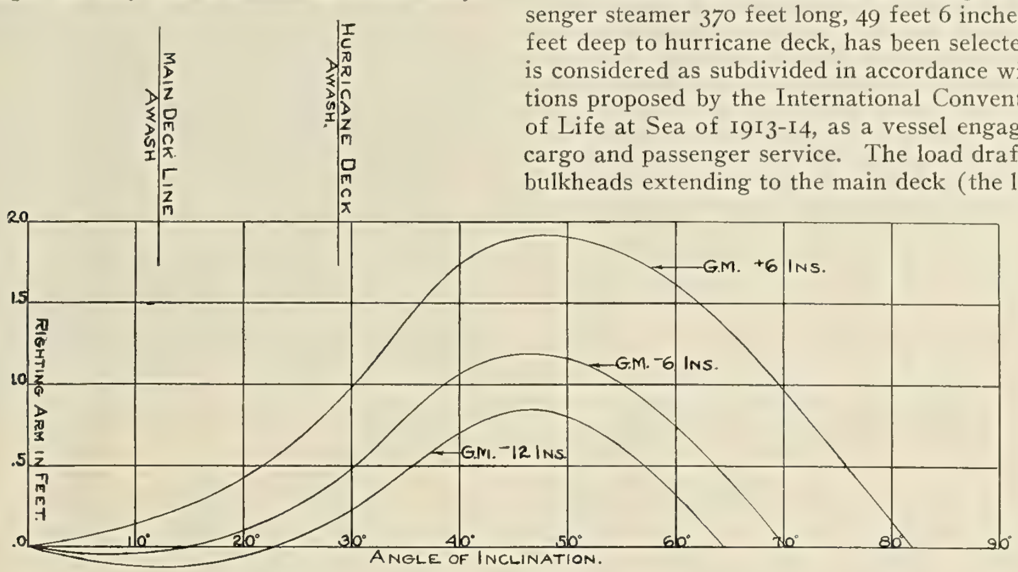


Fig. 1.—Stability Curve, 370-Foot Steamship—Intact—21.7 Feet Draft

The question is susceptible of several answers, depending on whether the vessel is considered as intact and exposed to storm and waves, or as "damaged" either in still water, in a moderate sea, or exposed to storms.

In general, it may be stated that passengers prefer a vessel with a long period of roll, as the discomfort is much reduced thereby. To obtain a long period it is necessary to have a large vessel or a small metacentric height; and the combination of the two requisites in the large Atlantic liners renders travel on them a pleasure instead of a bugbear to the landsman with a "sympathetic" stomach. If the small metacentric height is accompanied by a high freeboard and a considerable range of stability, there is small danger of capsizing, due to wind and waves, while "intact." This "comfortable" condition of a vessel, however, may be a source of great danger even in still water if the vessel is damaged by collision.

To illustrate the conditions obtaining, a coastwise passenger steamer 370 feet long, 49 feet 6 inches beam, and 35 feet deep to hurricane deck, has been selected. The vessel is considered as subdivided in accordance with the regulations proposed by the International Convention on Safety of Life at Sea of 1913-14, as a vessel engaged in a mixed cargo and passenger service. The load draft allowed with bulkheads extending to the main deck (the lowest point of which is 26.92 feet above base) and with machinery compartment 65 feet in length, is 21.7 feet. At this draft it is assumed that the cargo is so loaded that the metacentric height is 6 inches. The range of stability, as shown on Fig. 1, figures out at 82 degrees, and the maximum righting arm is 1.9 feet at 48 degrees inclination. It would be a pleasure to sail on this vessel under such conditions.

Now let us suppose that the machinery compartment is opened to the sea by collision, that the permeability of this compartment is .80, that the water surface in the damaged compartment at all stages has an inertia coefficient of .80, and that the water has free access across the

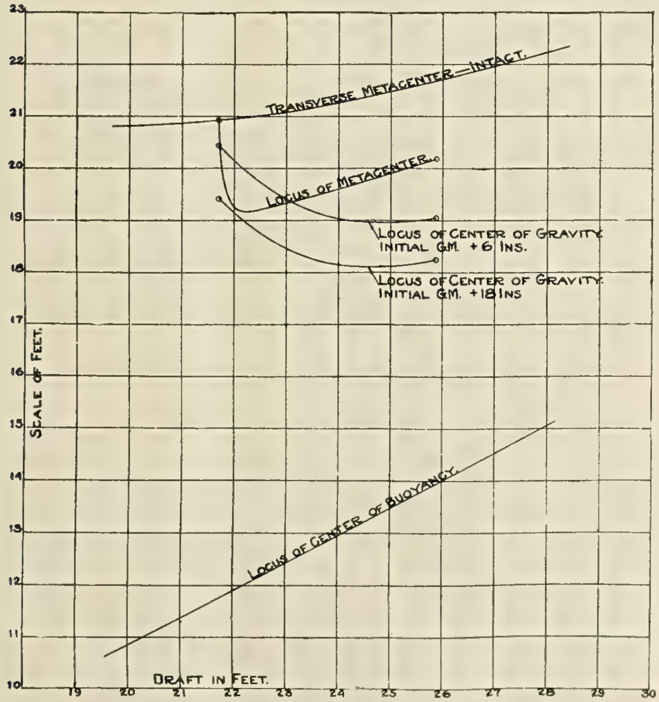


Fig. 2.—Variation of Initial Stability in Flooding Machinery Compartment

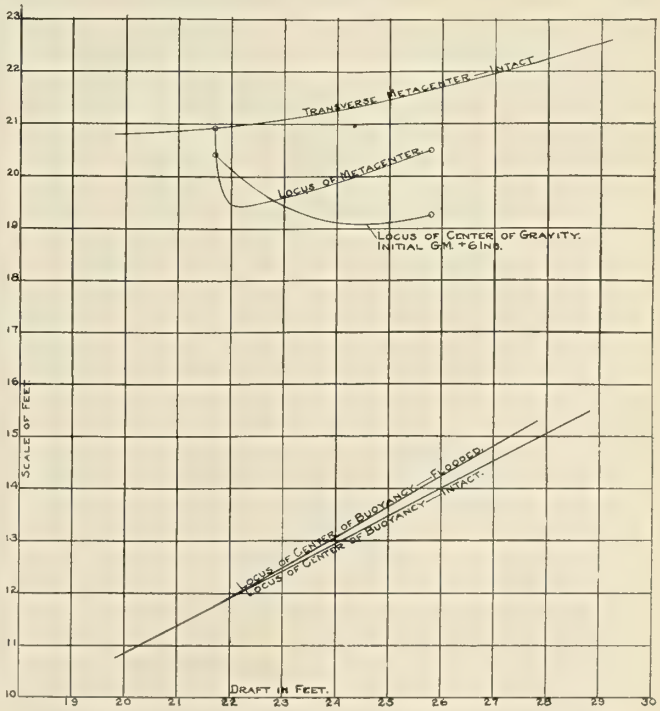


Fig. 3.—Variation of Initial Stability in Flooding No. 2 Hold

compartment. As the compartment fills, the center of gravity of the vessel and contained water would fall as indicated by the line marked "Locus of center of gravity" in Fig. 2. The center of buoyancy would rise as indicated by the line marked "Locus of center of buoyancy." The metacenter would fall as indicated by the line marked "Locus of metacenter."

A condition of unstable equilibrium is indicated almost as soon as the water begins to enter the vessel. If the vessel remained upright so that the center of gravity of the entering water would be on the centerline of the vessel, this condition of instability would continue only until the compartment was one-third full and a draft of 23.1 feet was attained. The metacentric height would rapidly increase as additional water entered, and would become as much as 1.1 feet at 25.9 feet draft, when the water would cease to flow in, having attained its level. The freeboard to main deck in this condition would be about 12 inches, and there would appear no reason why the vessel should not stay afloat in a perfectly calm sea, although the margin of safety as regards freeboard would seem insufficient except under ideal conditions of sea and weather.

But the combination of unstable equilibrium and the inflow of water from one side would surely cause the vessel to list toward the damaged side. This list would continue to increase even after there was a positive metacentric height indicated by the diagram, owing to the fact that the center of gravity of the flooding water would lie toward the low side, as obstructions would prevent a rapid flow across the compartment. Fig. 1 shows that the list caused by the negative *GM* would cause the main deck at the side to be submerged. When the main deck at the side is submerged, the water will flow forward and aft along the deck and flood the adjacent compartments, as well as further lower the metacenter. The list will continue to increase, and the vessel to settle deeper in the water and finally sink. The time elapsing from moment of damage to complete submergence would depend on a number of circumstances, but recent collisions have shown that not over fifteen minutes is sufficient.

After complete submergence, there would be a righting moment, due to the fact that the materials of the houses, etc., would be of less density than the material of the main hull. The cargo might be of such varying density as to give a righting moment also. It is probable, therefore, that as the submerged vessel rests on the bottom she would approach a vertical position with masts upright, or nearly so.

From Fig. 3 it will be noted that the conditions are not far different when No. 2 hold, 76 feet in length, is flooded. Permeability is taken at 64 percent.

It would appear, then, that in order to prevent this vessel from overturning when one compartment is open to the sea by collision, it is necessary that the initial metacentric height should be sufficient to prevent a condition of instability in any stage of the flooding. For the particular vessel which has been investigated, the initial metacentric height must exceed 1.4 feet by a margin sufficient to allow for the upsetting moment caused by the fact that in the process of flooding an excess of water will be on the damaged side.

If this vessel has an initial metacentric height of, say, 2 feet, and is subdivided in accordance with the rules of the International Convention, and when at the draft allowed by those rules is injured in a collision, with the consequent flooding of the machinery space or of an adjacent hold, the danger of overturning would seem to be eliminated, provided the sea is smooth. But if the permeabilities established by the conference represent average practice, the freeboard to the top of the bulkheads will be only about 12 inches. It would appear that, if the cut in the side is of any size, a very moderate sea would serve to send the water forward and aft of the damaged compartment, over the tops of the bulkheads.

The results of this investigation would seem to show two things:

First, for a coastwise passenger and freight vessel of the hurricane deck type, subdivided in accordance with the rules of the International Convention as a Class B vessel, and having a machinery space or holds of about one-fifth the length of the vessel, an initial metacentric height of not less than 18 inches should be an important element of the design.

Second, greater safety would be obtained by extending the bulkheads to the hurricane deck, or by otherwise preventing the flow of water fore and aft on the main deck.

Installation of 120 Horsepower Bolinder Oil Engine in Pilot Schooner Gracie S

The San Francisco Bar Pilots have recently installed a 120 horsepower Bolinder oil engine in the pilot schooner *Gracie S*. In many ways this installation is unique, both because it is the first of its kind on the Pacific Coast, and because the shaft is carried out through the port side of the vessel and supported by a strut instead of being located on the centerline. In order not to destroy the vessel's handling qualities, the center of the engine shaft was kept almost at the center of lateral resistance, so that the effects of the propeller on the steering would be neutral with the vessel going ahead.

The *Gracie S* was built at the Union Iron Works, San Francisco, in 1893. She is 83 feet long by 24 feet 7 inches beam, with a depth of 10 feet 2 inches, a gross tonnage of 91.4 and a net tonnage of 86.83. This little vessel is

Fig. 1.—Pilot Schooner *Gracie S*

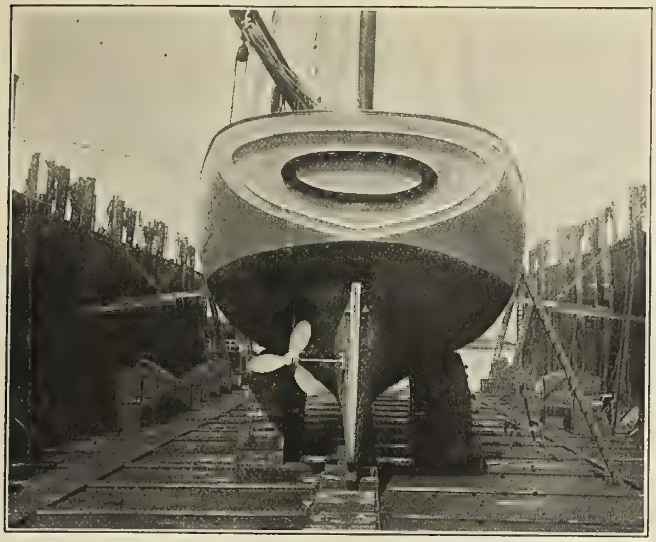


Fig. 2.—Propeller Located on Port Side of Vessel

of exceedingly staunch and heavy construction. On opening her up to install the shaft log in her side, the planking, frames and ceiling were found to be as solid and sound as the day they were put in.

It will be seen from Fig. 3 that the space on the port side formerly used as the dining room has been converted into an engine room, while a small dining room, having a capacity for eight pilots, has been retained on the starboard side. The forecastle forward, which has accommodations for a crew of six, remains practically unchanged; the galley occupies the same space as formerly. The pilots' quarters aft, which contain six berths, lockers, toilets, etc, remain practically the same as before, except that the water tanks, with a capacity of about 850 gallons, are placed under the floor, a space which was formerly occupied with pig-iron ballast, about forty tons of which was removed.

The alterations in the hull necessitated by the engine installation were made by Bowes & Andrews, in accordance with plans by and under the supervision of D. W. & R. Z. Dickie, naval architects, of San Francisco, Cal.

The main fuel tank, holding 737 gallons, is on the port side abreast the engine. A steel trunk skylight was fitted over the engine room extending past the main mast so as to hold the day tanks on deck.

Change of Trim

When the ballast was removed the vessel came up to a draft of 9 feet 10 inches forward and 7 feet 8 inches draft aft. After the installation was made, about 11 tons of loose ballast, consisting of steel plate punchings, was put in so as to trim the vessel properly, and when ready for sea her draft aft was 9 feet 11 inches.

Comparing her former trim before conversion with her finished waterline, it was found that she was up 5½ inches forward and 4½ inches aft, which corresponds to a decrease in displacement of 10¾ tons. Furthermore, her center of gravity is about 6.82 inches higher, due to the new arrangement of weights.

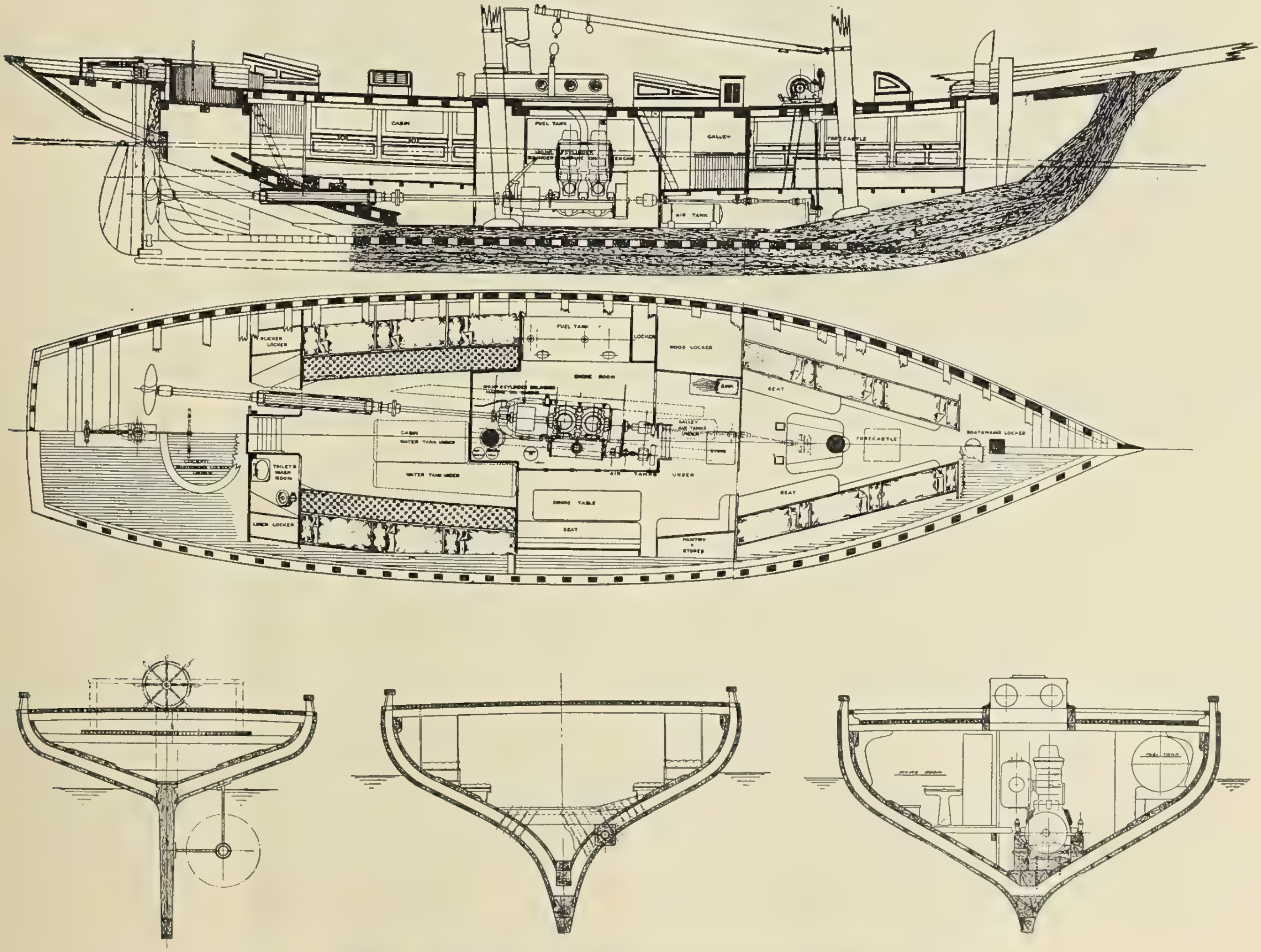


Fig. 3.—General Plans of Pilot Schooner *Gracie S*, After Installation of Oil Engine

On top of the engine room trunk skylight a ventilator stack was fitted in which the exhaust muffler and two whistles were carried. One of the whistles was an ordinary three-chime steam whistle and the other a Holman air whistle.

No auxiliary engine was fitted, but the bilge pump on the main engine was connected to a fire hydrant on the skylight trunk on deck, and a Gardner & Rix air compressor 4½ inches by 4½ inches, was arranged to be driven by a chain drive through a counter shaft and clutch.

Electric Installation

Hanging on brackets is a 45-volt, 1 kilowatt, direct current Bullock generator, running 1,200 revolutions per minute, which is driven from the counter shaft by means of a belt, it having been determined by previous experience that the running time of the engine during the day while on pilot duty would just about keep the storage batteries charged to operate the lights at night.

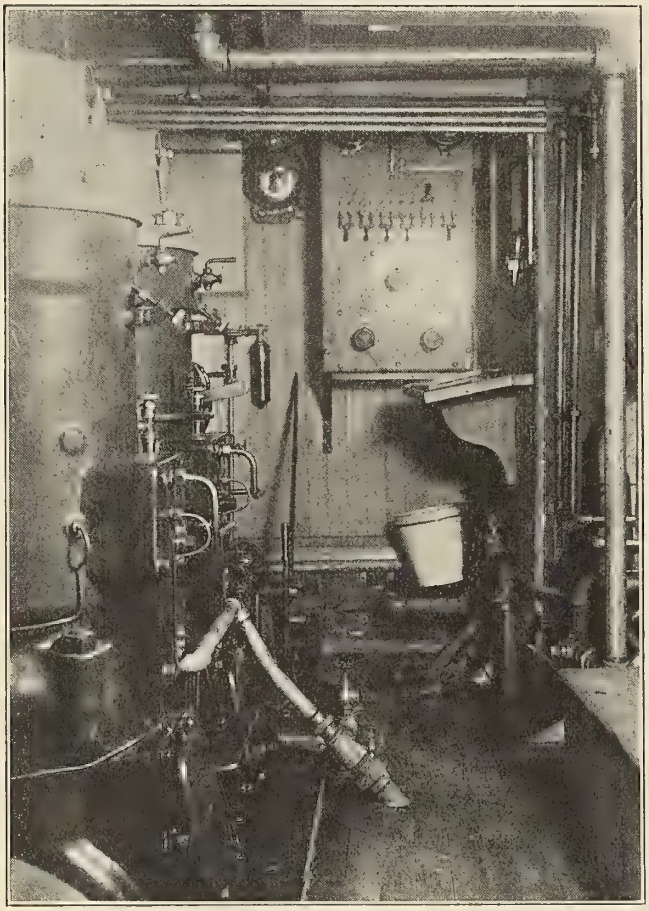


Fig. 4.—Engine Room

An Edison storage battery of twenty-five cells, of 80-ampere-hour capacity, giving 30 volts, was fitted, and on test it was found that after charging for eight hours the battery would carry all the lights that are usually burned in service for forty-four hours without recharging. The entire electric installation was made by the Marine Electric Company, of San Francisco. In order to light the dining room during the day, French plate glass was fitted in the panels of the engine room bulkhead.

On the deck forward, just aft of the mainmast, a No. 2 Hyde windlass of the yacht type was fitted. The worm gear is driven by means of a shaft and clutch from the main engine. The old steering gear was replaced by a No. 4 Hyde improved Robinson steerer, with the steering shaft extended forward, carried in a brass bearing stand, with a 42-inch steering wheel.

Reduced Sail Area

As dependence is to be placed on power, the former large sail areas are no longer required, and consequently the gaff was removed from the mainsail, that sail being made jib-headed with a head iron, and the bowsprit was shortened, thereby doing away with one jib. Under sail it was found that the vessel handled much better than she did previously when she was heavily ballasted, and carried the larger sail area that was necessary when she had to get off shore in a heavy gale. It was also found that the propeller offered little resistance, for as soon as the vessel got under way, getting up to a speed of four or five knots, the propeller revolves and the resistance is not noticeable.

Trials

On the trial course a speed of 9.04 knots was made with the engine turning 280 revolutions, and in service she has maintained this speed in her many runs for speaking vessels. It was found when running dead ahead the vessel steered exactly on her course and carried no helm whatsoever. In turning away from the propeller the time required to complete a circle was one and three quarter minutes, and while turning towards the wheel she took two and one-half minutes to complete the circle, swinging, however, in a shorter radius.

The engine has been somewhat of a revelation to those who have seen it working, especially as regards its reliability of reversing. It has been found possible to reverse the engine without releasing the clutch. Another point in favor of this type of engine is its complete absence of vibration or smell and the absolute safety of the kind of fuel used. The fuel is a residue from asphalt factories, known as star fuel, of from 23 to 26 degrees gravity at 60 degrees F., having a specific gravity of .9105, an open flash of 180 degrees F., a closed flash of 166 degrees F., and a burning point 235 degrees F. The characteristics of the fuel are asphaltum, 25 degrees; sulphur, ¾ percent; British thermal units, 19,200; pounds per U. S. gallon, 7.485; viscosity, about 323 at 15 degrees C. The fuel costs 90 cents (3/9) a barrel (42 gallons) in San Francisco.

The propeller was designed with a large diameter—58½ inches—and a correspondingly small surface ratio of 30 percent, so as to offer little resistance while sailing. The propeller absorbs 134 horsepower when the vessel is making 9 knots, and when driving into a head sea the engine holds up to her rated revolutions, showing that the engine has a large surplus of power.

In order to start the engine it is necessary to preheat the bulbs with the coal oil torches. The usual time required for this is from twelve to fourteen minutes, but once the engine was tried at the expiration of six minutes and it started without a hitch.

From the daily log that has been kept by the engineer since the vessel went in service, the maximum fuel used has been a little less than 8 gallons per hour under full load, and the average fuel used per hour of running is about 7 gallons. It will be seen from the above that it costs about 15 cents (0/7½) per hour for fuel to operate the *Gracie S.*

It is interesting to note that the United States Navy has bought a 50 horsepower Bolinder stationary engine to be used on the new collier *Maumee* as an auxiliary electric lighting plant, while her main engines are to be of the Diesel type.

Electric Towing System at the Panama Locks

General Arrangement of the Locks—Method of Towing—Construction of Electric Locomotives—Safety Features

In passing through the Panama Canal from the Atlantic to the Pacific, a vessel enters the approach channel in Limon Bay, which extends to Gatun, a distance of about 7 miles. At Gatun the vessel enters a series of three locks in flight and is raised 85 feet to the level of Gatun Lake. It may then steam at full speed through the channel in this lake for a distance of 24 miles, to Bas Obispo, where it enters the Culebra Cut. After passing through this cut, which has a length of nine miles, the vessel reaches Pedro Miguel, where it enters a lock and is lowered 30 feet. Then it passes through Miraflores Lake for a distance of 1½ miles until it reaches Miraflores, where it is lowered 55 feet through two locks, to the sea level, after which it passes out into the Pacific through an 8½-mile channel.

Fig. 1.—Towing Locomotives Returning Barge Through Gatun Locks to Atlantic Level

The Locks

As the main features of all the lock sites are identical, the general layout of the Gatun Locks is shown in Fig. 1. It should be noted that there are two ship channels, one for traffic in each direction, which are separated by a center wall, the total length of which is 6,330 feet. There are two systems of tracks, one for towing and the other for the return of the locomotive when returning idle. This, however, refers only to the outer walls. For the center wall there is only one return track in common for both the towing tracks. The towing tracks are naturally placed next to the channel side, and the system of towing utilizes normally not less than four locomotives running along the lock walls. Two of them are opposite each other in advance of the vessel, and two run opposite each other following the vessel, as seen in Fig. 1. The number of locomotives is, however, increased when the tonnage of the ship demands it.

Cables extend from the forward locomotives and connect with the port and starboard sides of the vessel respectively near the bow, and other cables connect the rear locomotives with the port and starboard quarters of the vessel. The lengths of the various cables are adjusted by a special winding drum on the locomotive to place the vessel substantially in mid-channel. When the leading locomotives are started, they will tow the vessel, while the trailing locomotives will follow and keep all the cables taut. By changing the lengths of the rear cables the vessel can be guided, and to stop the vessel all the locomotives are slowed down and stopped, thus bringing the rear locomotives in action to retard the ship. Therefore the vessel is always under complete control quite independent of its own power, and the danger of injury to the lock walls and gates is very greatly lessened.

Fig. 1 shows how effectively the four locomotives keep

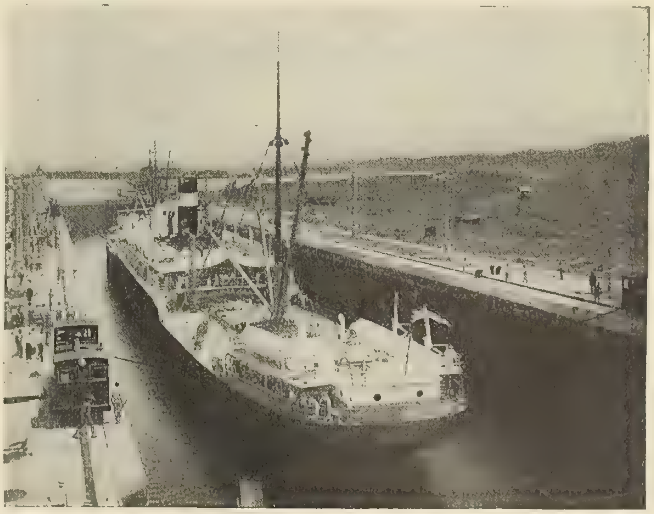


Fig. 2.—S. S. *Aucon* Entering Upper Lock Under Tow of Electric Locomotives

the vessel under control and in the center of the channel, while Fig. 2 gives a general idea of the method of handling vessels of various sizes. The views also give an idea of the lock walls, towing tracks and the inclines, the steepness of the latter being especially noticeable. Of particular interest is Fig. 2, which represents a trial tow approaching the second level. The water in the middle lock or at this second level is at sea-level, a condition not obtained in regular operation, and this trial was made to demonstrate that the tow lines would clear the lock walls.

Towing Tracks

The towing tracks have a specially designed rack rail extending the entire length of the track and located centrally with respect to the running rails. It is through this rack rail that the locomotive exerts the traction necessary for propelling large ships and climbing the steep inclines.

A rack rail is also provided on short portions of the return track so as to lower the locomotives safely from one level to the next. The steepest slope is 26 degrees, or 44 percent, hence the need will be seen for a rack rail even on the return track, as any traction locomotive with the usual wheel drive, even with the brakes set, would begin to slide on a 16 percent grade and therefore could not be controlled. With a rack rail, however, traction is limited only by the capacity of the driving motors and not by the adhesion of the wheel treads on the rails.

The approach to the rack rail is hinged to the rack rail proper, so that it can be depressed on the approach of the rack pinion of the locomotive. The teeth of the approach section are under size and shaped off at the extreme end so that the teeth of the pinion will mesh properly and prevent excessive strain on the pinion and the axle. A spring restores the approach to the proper position after the locomotive has passed over. The rack rail is of the shrouded type, and each tooth space has a drain hole cast in the bottom so as to carry off water and other accumulations to suitable drain pipes or ducts set in the concrete of the walls. A further feature of the rack rail is the projecting edges, which permit thrust wheels attached to the locomotive to run along the under side and prevent overturning of the locomotive, in case some unforeseen operating condition should produce an excessive pull on the towline. These thrust wheels serve to counteract the lateral component of the towline pull and the flanges act for emergency only, as the weight of the locomotive is, however, sufficient to prevent overturning with a normal pull of 25,000 pounds on the towline.

Motors

Three-phase, 25-cycle, 220-volt alternating current is used for operating the locomotives, and the current is supplied through an underground contact system. Two T-rails form two legs of the three-phase circuit and the third leg is formed by the main track rails. A specially designed contact plow slides between the two "T" conductors and transmits the power from the rails to the locomotive. This contact plow also passes through the slot opening in the conduit cover and is flexibly connected to the locomotive in such a manner as to follow all irregularities in the tracks and crossovers, and therefore insures a continuous supply of power.

The locomotives are equipped with two main traction motors of the slip ring induction type, each rated at 75 horsepower and operated by a system of contactors with master controller in cabs at each end of the locomotive. The motors, by means of a change in gearing from straight traction to rack rail towing, drive the locomotive at a speed of 2 miles per hour when towing and 5 miles per hour when returning idle. These motors act as induction generators running above synchronous speed when the locomotive is passing down the steep inclines, and thereby exert a retarding brake effect to keep the speed uniform.

The towing locomotives, which have a net weight of 86,300 pounds, possess the following operating characteristics: (1) While towing, the speed can be regulated from zero miles to 2 miles per hour; (2) while running idle, the speed can be regulated from zero to 5 miles per hour, permitting return trips at increased speed; (3) the windlass will pay out or wind in cable at the low rope speed and at the full towline pull of 25,000 pounds, either when the locomotive is running or at rest; (4) the windlass will pay out or coil in cable at the high rope speed with the towline taut, either when the locomotive is running or at rest, and (5) the windlass is equipped with a safety friction device, which is adjustable to any predetermined value of the towline pull.

Traffic Through the Canal

During the first three months of commercial operation of the Canal, from August 15 to November 15, 1914, the cargo transported through the Canal and towed through the locks by the locomotives amounted to 1,079,521 tons. During the fiscal year ending June 30, 1914, the Panama Railroad carried 643,178 tons of through freight between the two seaboards, and in the preceding fiscal year 594,040 tons. From this it is seen that between six and seven times as much cargo is passing over the Isthmus now as passed over this route when goods were transshipped by rail.

The towing system described above was designed and patented by Mr. Edward Schildhauer, electrical and mechanical engineer of the Isthmian Canal Commission, and the forty towing locomotives and all the electrical apparatus for operating the locks were built by the General Electric Company, Schenectady, N. Y.

Institution of Naval Architects

At the annual meeting of the Institution of Naval Architects, held in the Hall of the Royal Society of Arts, John street, Adelphi, London, on March 24 and 25, the following papers were read and discussed:

The Watertight Subdivision of Ships. By Professor J. J. Welch, M. Sc.

The Increase of Safety Afforded by a Watertight Deck. By Kenneth G. Finlay.

The Influence of Discharging Appliances on the Design of Large Ore-Carriers. By John Reid.

The Scantlings of Light Superstructures. By J. Montgomerie, B. Sc.

On the Strength and Spacing of Transverse Frames. By C. Frodsham Holt, B. Eng.

A Contribution to the Theory of Propulsion and the Screw Propeller. By F. W. Lanchester.

A Comparison Between the Results of Propeller Experiments in Air and Water. By A. W. Johns, R. C. N. C.

Further Model Experiments on the Resistance of Mercantile Ship Forms: The Influence of Length and Prismatic Coefficients on the Resistance of Ships. By J. L. Kent.

The Law of Fatigue Applied to Crankshaft Failures. By C. E. Stromeyer.

The Effect of Beam on the Speed of Hydro-Aeroplanes. By Linton Hope.

Notes on the Cross Curves and GZ Curves of Stability. By E. F. Spanner, R. C. N. C.

Introduction of a Modern Method in Shipbuilding

BY WILLIAM BROWN *

In shipyards years ago the bent frames and floor plates for a ship were carried in their raw state to the scribe board so that they could be laid out for punching. After these slow and expensive operations all other work was templated from the ship. Present-day practices in shipyards, however, demand that 95 percent of all structural work be developed from the scribe board. But in spite of the enormous strides that have been made in this industry in the last third of a century, no shipbuilder can successfully deny that many operations are still distressingly slow and expensive, and entirely out of harmony with even the rudiments of scientific management. In fact, many operations in present-day development of structural work on ships could be carried on much more economically and expeditiously under the system of years ago.

This statement may sound strange and somewhat contradictory, but it is none the less true. For instance, under the present system a bulkhead, say, is laid down on paper in the mold loft, and then the paper is transferred to the plates for laying off, plate by plate. The old way was to place the bulkhead plates in their respective positions and lay them off direct, thus obviating the expense of making templates. Not only did this apply to bulkheads, but to sections of decks, bottom and side plating, and inner bottoms. It must be said, however, that such procedure required considerable space in the yard for laying off purposes.

What is wanted is a system that will eliminate the waste of time and money of past and present methods. But the accomplishment of this happy medium is a task that has baffled many shrewd investigators in this field of endeavor.

Naturally, the first question that suggests itself is, Where shall the start be made? We must look for our answer in the drawing room. It is there that the old customs survive, and the sooner that this branch abandons some of its archaic customs, the sooner will the quickened pulse be felt in the shipyard proper. What happens at present? When the model arrives the draftsman takes it in hand to line it up in exactly the same manner as he did years ago. His one aim and ambition in life seems to be to develop beautiful lines showing the plate edges, apparently for no other reason than because somebody started a job that way in the dim, distant past. Of course, every practical shipbuilder fully realizes the necessity of having good and fair plate edges, but at the same time the employer should justly receive a little consideration while those same beautiful lines are being developed. Reference here is not made to shell plating only; the same remarks apply to decks, bulkheads, inner bottoms, outer bottoms, and inner and outer keel plates.

Under the method here proposed let us accompany the model to the drafting room and begin by giving the draftsman his orders as to the development of the lines. Fair lines are wanted, of course, but why not instruct him to lay out as many rectangular plates of the same width and length as possible? Length is really not so necessary as width, as the former dimension can readily be obtained without change of design. The number of rectangular plates that can be obtained from a ship's bottom, side plating, decks and bulkheads, will afford much surprise to those who have not given the matter special consider-

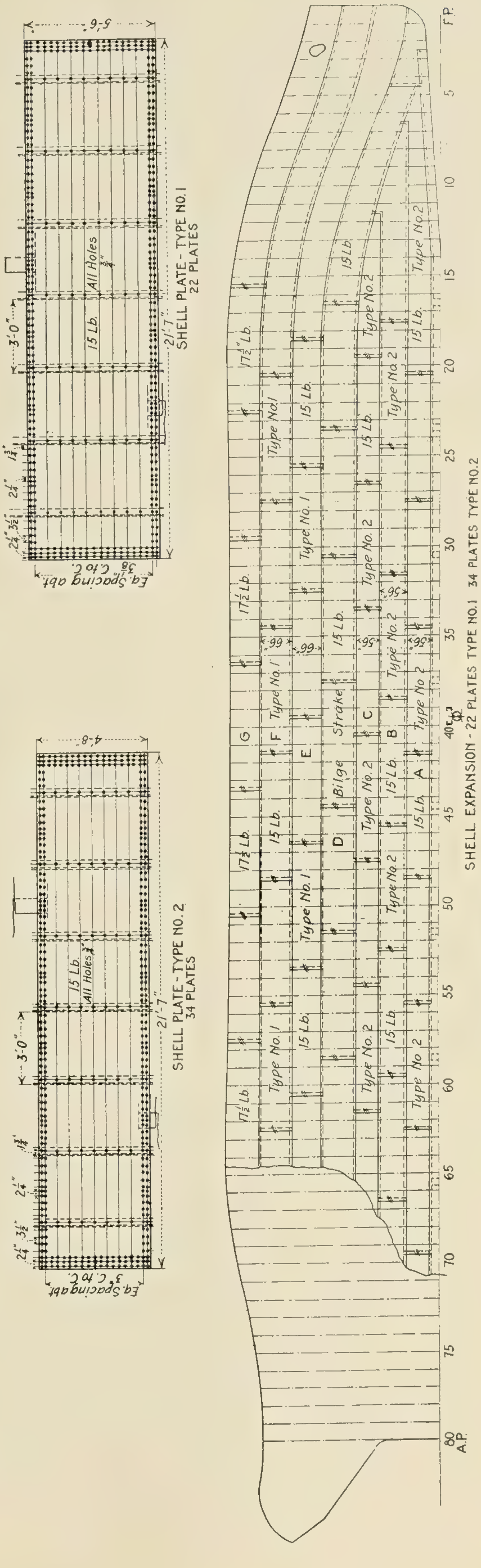


Fig. 1.—Expansion of Shell Plating with Layout of Type Plates

* Master Shipfitter, League Island Navy Yard, Philadelphia, Pa.

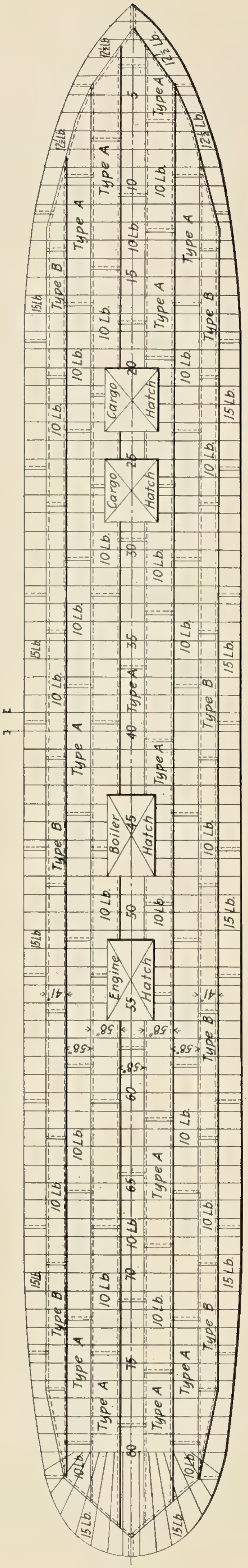


Fig. 2.—Deck Plating Plan. 32 Plates Type A. 16 Plates Type B

ation. Figs. 1, 2 and 3 give a rough but approximate idea of what can be accomplished in this direction.

Criticism will aptly show, of course, that the figures indicate a ship with long, flat sides and bottom. It is needless to point out that the system proposed is not applicable to every ship, for such a contention could not be borne out, but it is stoutly maintained that the procedure here outlined is well adapted to a high percentage of shipbuilding work.

Size type plates as shown in Figs. 1, 2 and 3 will be ordered by the draftsman, and no shearing will be required. Emphasis can here again be laid on the expensive methods employed at present. In most shipyards the templates for all plates are developed in the mold loft, after which they are passed to the shipfitter for laying

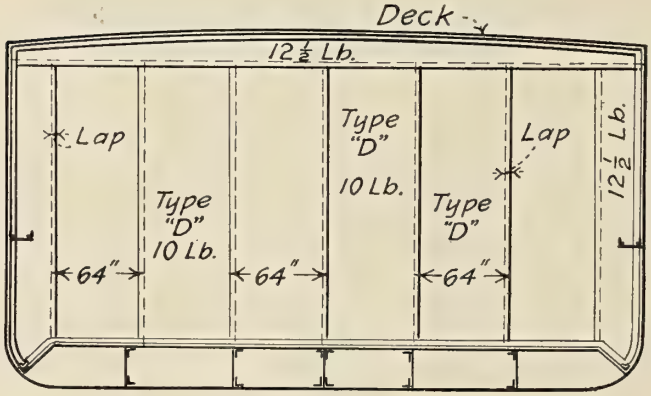


Fig. 3.—Bulkhead Plan—6 Plates Type D

out. The plates having been laid out, are taken to a punch, and after punching they are sheared. An average of 2,500 to 3,000 holes by one punching gang is considered a good day's work.

Now, let us see what happens to the type plates as shown in Figs. 1, 2 and 3. First of all, there must be introduced into shipbuilding a machine known as an automatic spacing table with multiple punch, equipped with gag control mechanism. The machine is designed primarily for plate punching, but with equal facility it can be used for punching any straight angle work. Instead, however, of the 2,500 to 3,000 holes a day punched by a gang under the old methods, this machine has the astonishingly large output of 60,000 to 80,000 holes a day depending entirely on how often a change is necessary in the gag control to suit the different sizes of plates. This, too, is accomplished with no increase in the labor necessary under the old, cumbersome methods previously described.

This result is made possible because no template for the plate is required. The plate is not laid off at all; it enters the machine in its raw state exactly as it comes from the mill. The spacing table is regulated by one strip of template wood about ⅝ inch by 2½ inches, in sections corresponding to the actual length of the plate to be punched, and this is laid out from the plan either in the drawing room or in the mold loft. The details of setting up the spacing table and gag control are very simple, requiring no mechanical ability. The spacing table removes all guesswork, there is no contraction or expansion of paper templates, and all that is required is the small strip of wood just referred to. Not only will the use of the methods here outlined result in great economy in punching, but it will effect corresponding economies by eliminating making templates and marking plates.

Mention was made of the automatic control of the machine here described, applying particularly to where a large number of duplicate parts are required. This feature relieves the operator from the necessity of devoting any of his time to the gags and effectually eliminates the possibility of error. On ship work, however, on account of the frequent changes necessary, the gag can be controlled by hand levers, and to avoid the possibility of error a signaling system is used to indicate the point where important changes occur.

The accuracy of spacing obtained on a machine of this type was strikingly demonstrated in the case of eleven plates 60½ inches wide, 9/16 inch thick and 21 feet long. Holes 15/16 inch in diameter were punched in each one of the eleven plates, and when the plates were brought evenly together, face to face, a ⅞-inch bolt was loosely inserted in every deep hole caused by the individual punchings.

Notes on the Conversion of Cargo Vessels into Bulk Oil Carriers

BY F. K. RUPRECHT *

At times the demand for boats of a certain type for special cargoes exceeds the supply. This demand is of a temporary nature and in some cases would be all over by the time a fleet of new vessels could be constructed for this special purpose. Often the need is not so great as to warrant the construction of a fleet, and it is then that the owner looks toward conversion.

Conversion from one type of vessel to another for special purposes is not an old idea in shipbuilding, for, since the real type vessel is a recent invention, so also is conversion. From a structural viewpoint the conversion of vessels into bulk oil carriers is probably the most difficult and interesting problem in shipbuilding.

Some time ago a greater oil-carrying tonnage was demanded by a sudden increase in trade. The shipyards were all busy and behind time with contracts for this type of vessel. This condition forced the transportation companies to turn to conversion. The idea was not hailed with delight, because it is not a cheap job to convert a general cargo boat into a tank ship.

Strength of the Vessel

The first requirement in a convertible vessel is strength. Some ships, while having ample strength for their trades, have not that extra degree required for bulk oil carriers. Oil is a "dead" cargo, and so causes extra stresses in the hull. In a seaway the oil gets into motion and the stresses caused by it are of a nature unknown to the general cargo vessel. Besides being strong the hull must be in an especially well preserved condition. It is easy to see what a great expense it would be to try to fit new oiltight work on old work in poor condition. It would be practically impossible to fit an oiltight deck on corroded beams or to fit a bulkhead on unfair or corroded plating.

The type of vessel must also be suitable for conversion. A large single-deck vessel, for instance, would be very expensive to convert, because she could not carry herself full and so an extra deck would have to be added to limit the size of the oil tank and provide an expansion trunk. In a three island vessel, one with a long bridge or poop deck would also involve extra construction, for the long erections would have to be replaced by smaller ones to keep them clear of the expansion trunk hatches and pump-room entrances. A complete shelter or spar deck vessel involves the least difficulty, providing she has two complete decks besides—i. e., main and upper decks. A three or a two deck vessel involves the least extra construction. If there are not two complete decks, the problem of a proper expansion trunk becomes difficult, because no vessel could carry oil up to the upper deck and then the expansion truck above that. We thus see that the number of convertible ships is not as large as might be imagined, because only a modern high-grade type of vessel would be worth the cost of conversion.

Another question that has to be dealt with in conversion is whether the boat is to be an oil carrier permanently or only for a period of a few years. The consideration of this problem involves the question of structural design and general arrangement. The new work must be designed so as to offer the least interference to subsequential use of the vessel in the general cargo trade, or so that it can be changed for the purpose to a greater or less degree at a reasonable expense. This applies more directly to hatches, expansion trunks and access to the smaller compartments, due to subdivision. In the earliest conversion jobs the owners seemed to be doubtful of success, and so found it advantageous to burn as few of their bridges behind them as possible. Needless to say, the jobs were successful, but now they have boats that can easily be sent back to their old trade without too great a loss of space or money.

Location of the Machinery

The location of the machinery is another question of importance. The modern tanker has her engines and boilers aft of all oil tanks and pump rooms, but very few convertible vessels will be found with their machinery anywhere but amidships. This arrangement involves extra expense and weight of steel work, for we have to provide four complete cofferdams and two pump rooms, as against two of the former and one of the latter in the type of vessel with her machinery aft. If internal combustion engines were the rule, one of the two pump rooms could be done away with by passing the oil lines through the engine room in an oiltight, well-ventilated tunnel.

The following remarks deal mostly with a type of vessel with her engines and boilers amidships. In this case we have a more difficult problem, and all the principles involved can be applied to the other type of vessel.

The first thing to be considered is the proposed general arrangement of the vessel. This is more or less a problem of the location of transverse bulkheads. The different registration societies, such as Lloyds and Bureau Veritas, limit the length of the oil tanks to between 24 and 28 feet. The object of this is to prevent the oil from getting so much momentum when the ship is pitching as to break down the bulkheads. The foremost end of the forward cofferdam is fixed, insomuch as the crew quarters must be forward of this bulkhead. If desired, this space may be reduced by one or two frame spaces in order to give a better arrangement of bulkheads.

If the crew is not housed forward, the location of the foremost bulkhead will be fixed with regard to a dry hold aft of the chain locker and fore peak and forward of the cofferdam. This space is used for general cargo or ship's stores, and will usually be about six frame spaces in length. Aft of this will be a two-frame space cofferdam, aft of which will be the oil cargo tanks. The space available for these tanks will depend on several conditions. If the vessel is a coal burner, ample space must be provided

*Associate Member Society of Naval Architects and Marine Engineers.

for a cross bunker. Coal may be also carried in the 'tween deck bunkers alongside of the engine and boiler spaces, as well as alongside the expansion trunks, or in some cases in the shelter 'tween decks outside of the gastight trunks around the hatches.

In certain trades all possible space must be given up to coal and this condition will decide the design. In some cases ample coal may be carried in the 'tween deck bunkers alongside the boiler and engine room spaces and the cross bunker. Then the space alongside the expansion trunk could be converted into summer cargo tanks.

Pump Room

Beside the cross bunker we must have space for another cofferdam forward of it and for a pump room. These two may be combined—that is, make the cofferdam large enough to hold the pump room and be a one-frame space cofferdam besides. Five or six frame spaces will, as a rule, be ample room for this. Another arrangement that can be adopted is to have only the required two-frame space cofferdam and have a pump room in the aftermost oil tank of about four or five frame spaces. This arrangement gives a smaller carrying capacity and the pump room is more liable to be flooded, because two of its sides are formed by main cargo bulkheads. However, this method is used in almost all of the modern tank ships, and with good workmanship seems to give no trouble. In the former arrangement the one-frame space cofferdam may come between the oil tank and pump room or between the pump room and the cross bunker. The former arrangement is preferred, because the pump room is less liable to be flooded and greater safety in case of fire is secured. The pump room will not extend the total width of the vessel, but only to the centerline bulkhead. The floor may be laid on the tank top or may be of the suspended type. The forward and after pump rooms will be arranged on opposite sides of the centerline bulkhead, and the weights of the structure and the water ballast will be balanced in this way.

Fuel Oil Bunker

If the vessel is fitted, or is to be fitted, for oil fuel, the foremost and aftermost cofferdams may be used for bunkers. The space mentioned above for the cross coal bunker may be used for the fuel, and, if considered necessary, a cofferdam may be fitted between the bunker and the boiler room, as well as one between the cargo and the fuel tank. The latter cofferdam may be dispensed with if the ordinary pump room is installed. In this case the centerline bulkhead will be carried through the fuel bunker.

The arrangement of cofferdams and pump room aft of the engine room would be similar to the forward ones except that no coal or fuel bunker need be provided. Aft of the aftermost cofferdam a dry hold should be provided for access to the shaft tunnel and to provide, if possible, means for getting in or out the spare tail shaft. A fair size hatch should give access to this hold, as well as a smaller trunk with a booby hatch on the weather deck for access to the tunnel.

Having found the space available for oil tanks it is best to divide it up equally into the desired number of tanks. The question of trim in the loaded and ballast conditions should be looked into and the length of the foremost and the aftermost tanks made so as to give the desired effect.

In designing the expansion trunk the width is the only variable, because the height will be the height of the 'tween decks. The width will have to be fixed by considering the carrying capacity of the vessel and should be such as to bring the vessel to her load waterline when about three-quarters full. The width must not, however, exceed sixty percent of the beam of the vessel. The trunk bulkheads will be continuous through the cofferdams, although in the latter they need not be oiltight.

(*To be continued.*)

Two New Crandall Railway Dry Docks

Two railway dry docks have recently been completed by the Crandall Engineering Company, East Boston, Mass., one in the harbor of Havana, Cuba, and the other at the Port of Selkirk, Manitoba, on the Red River of the North near its entrance to the southern end of Lake Winnipeg. The first of these was built for the Havana Marine Railways, Inc., an American Company, which has installed a ship repair plant at that port. The other dock was built for the Department of Public Works of the Canadian Government, which maintains a repair depot at Selkirk for its dredges and other building equipment. It is interesting to note that the Crandall Engineering Company, who designed and constructed these docks, have built about a hundred railway dry docks of this type in various parts of the world, many of which have been illustrated in previous issues of this journal.

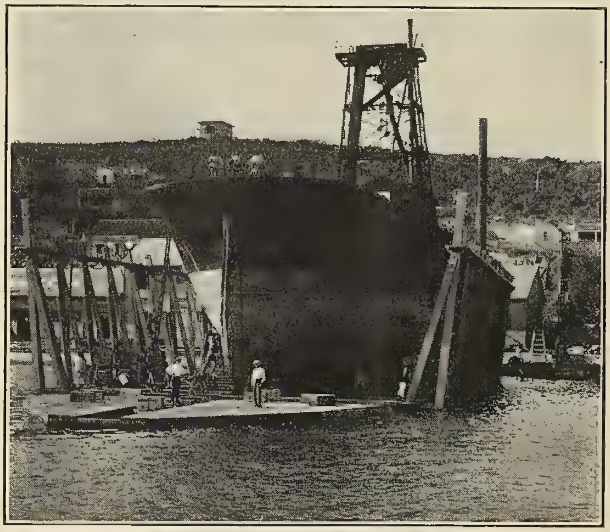


Fig. 1.—Crandall Dock at Havana

The new dry dock at Havana is 260 feet long over keel blocks, 280 feet long over the floor, 60 feet wide with 12 feet of water over the keel blocks forward and 17 feet aft. The capacity of the dock is 2,200 tons, and with quadruple hauling chains which are operated by steam hoisting machinery, a vessel of the full capacity of the dock can be hauled out within the short space of 18 minutes after being centered and blocked.

The dock is constructed of timber protected against the action of toredo, except such parts as are permanently above water, the latter being of reinforced concrete. The foundation is piling driven to bedrock. Patent releasing bilge blocks are provided and the carriage travels upon a three-way track on the free roller system.

Construction of this dock was begun in January, 1914, and completed in September after considerable delay owing to cancelling of concessions by the Cuban Government, which tied up all dredging operations in the harbor. Besides the dry dock, however, the company installed machine, plate, boiler and smith shops equipped with first class modern tools, and has provided for future exten-

sions in this line. It will undoubtedly be a relief to many ship masters and owners to know that there is an up-to-date repair plant at Havana under American management.

The dry dock at Selkirk is of 1,500 tons capacity, 192 feet long on the keel blocks, 212 feet long over the floor, 52 feet wide, and at ordinary summer levels has a draft of 11 feet over the keel blocks forward and 15 feet aft. Electric power is used in this case in operating the dock, and a full load of 1,500 tons may be hauled out in fourteen minutes after being blocked.

Fig. 2.—Crandall Railway Drydock at Selkirk, Manitoba

The carriage is built in two sections, the upper being entirely open on one side to allow boats to be tracked to the yard. It is so designed that at a later date a transfer cradle may be fitted to move vessels from the cradle to the yard. The carriage is of composite construction, the main frame being of fabricated steel and the balance of wood.

There are three tracks of timber resting on a foundation of piling. In order to obtain the required length and keep clear of the main ship channel, it was necessary to cut back into the river bank. The sides of the cut are held up by concrete retaining walls on a pile foundation.

The contract for this dock was signed early in 1914, but, owing to the fact that the ground in this part of the country freezes to a depth of 6 to 7 feet in the winter, it was impossible to begin excavation until the latter part of May. The work was completed, however, early in October, and the dock was tested successfully on November 5.

Storm Damages French Liner Gascogne.—During a northeast gale which raged in mid-Atlantic from March 7 to 9, the French liner *Gascogne,* bound from Havre to New York, was seriously damaged. Heavy seas tore away the deck rails, swept away the forward funnel a few feet above the deck and loosened the aft funnel, threatening at times to swamp the vessel. The ravages of the storm can be seen from the photograph shown below.

(Photograph Reproduced from New York Herald)

Deck of French Liner *Gascogne*, Showing Forward Funnel Wrecked by Storm

(Photograph Copyright by London Daily Mail)

German Armored Cruiser *Bluecher* (15,500 Tons, 32,000 Horsepower, Armed with Twelve 8.2-Inch and Eight 6-Inch Guns) Foundering After Having Been Shelled and Torpedoed in Running Fight Between British and German Squadrons in the North Sea

The Latest French Destroyers

Among the latest additions to the French Navy are the four destroyers *Aventurier, Opiniatre, Temeraire* and *Intrepide,* which are the largest vessels of their type now under the French flag. All of these destroyers were built and engined by the "Britany yard" at Nantes. Their main particulars are: Length overall, 283 feet; beam, 28.32 feet; depth, 17 feet; draft, at the stern, 10 feet; displacement, 1,100 tons.

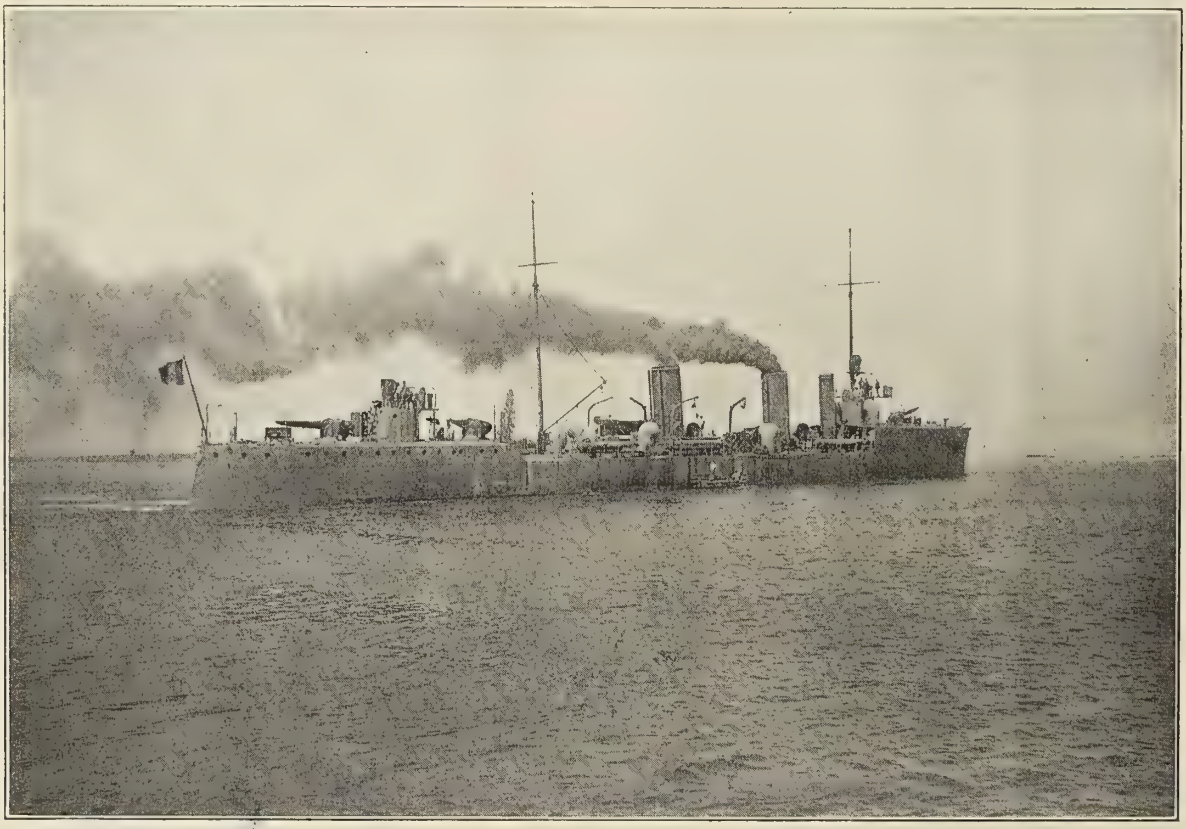
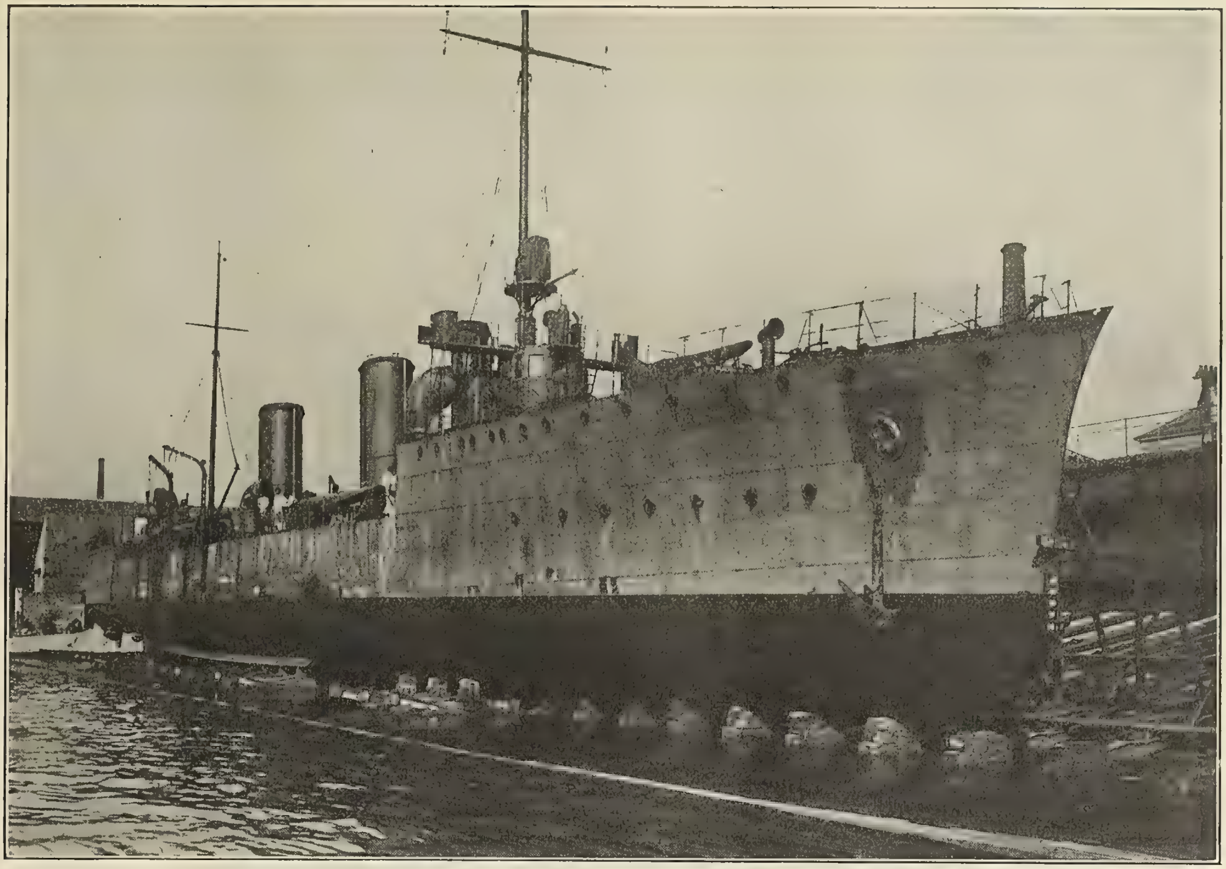


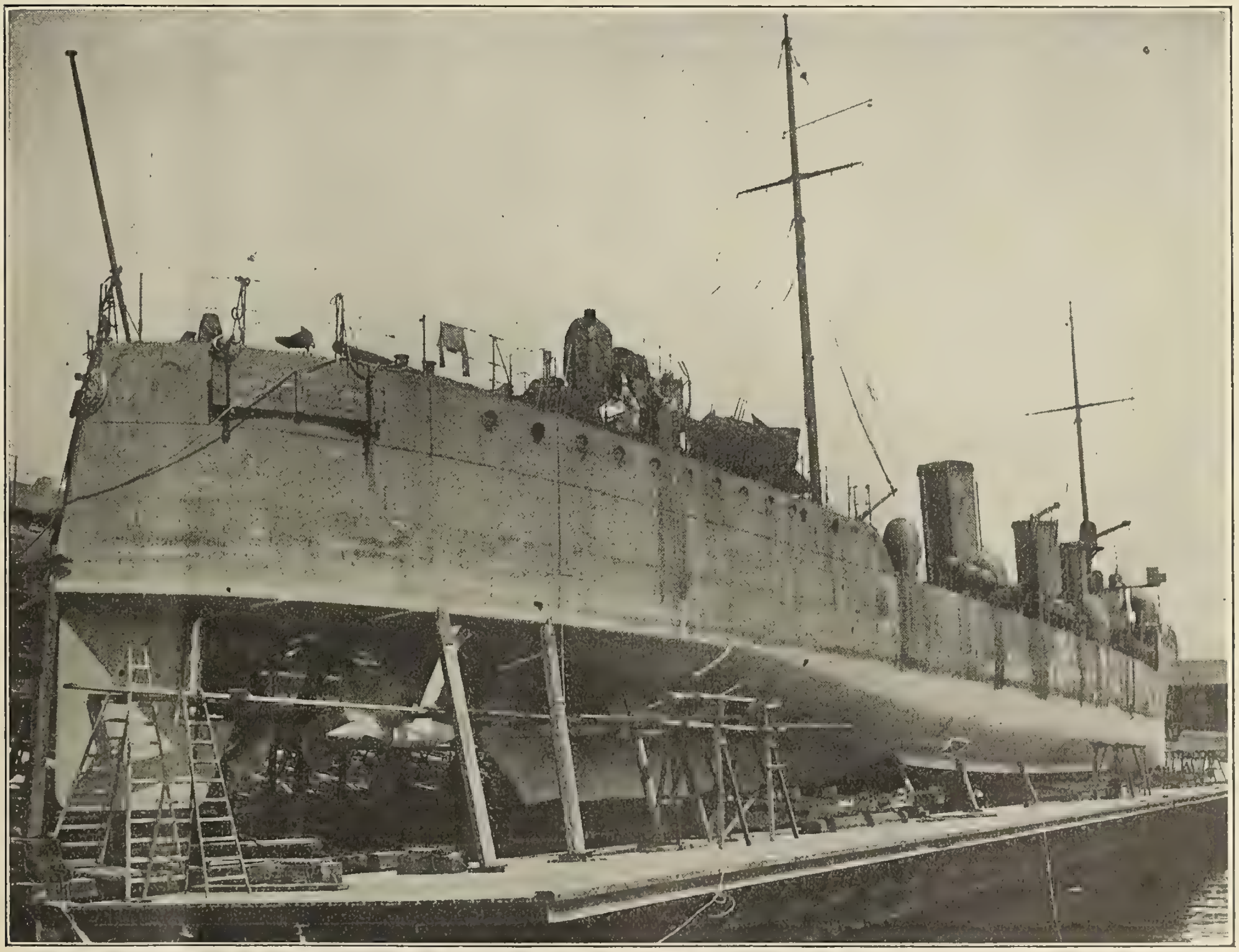
Fig. 1.—One of the New French Destroyers on Trial

The type of hull is the same as adopted in the previous destroyers *Voltigeur, Fourche,* etc., which have been illustrated and described in previous issues of this journal. This type of design, however, has proved very efficient, allowing the propellers to give their maximum efficiency even in bad weather. Their seaworthiness has been amply proved in actual service during the winter months.

The engines consist of two Rateau turbines, each driving a propeller 7 feet 3 inches diameter and 6 feet 9 inches pitch, working at 650 revolutions per minute. The total horsepower developed is about 20,000, and it is reported that speeds of 32 knots were obtained on the measured mile trials. Steam is supplied by four watertube boilers, using coal as fuel, and a fifth fired with oil fuel. The capacity of the coal bunkers is 12,362 cubic feet and of the oil tanks 3,179 cubic feet. The destroyers have an acting radius of about 3,000 miles.

The armament consists of four 4-inch rapid fire guns, all mounted on the centerline of the vessel, and four 18-inch torpedo tubes.





Figs. 2 and 3.—Bow and Stern Views of 1,100-Ton French Destroyer

Output of Japanese Shipyards in 1914

The total output of Japanese shipyards in 1914 amounted to 136,310 gross tons. Nearly 82 percent of this tonnage, or 111,343 gross tons, consisted of 18 steamers, all of which were above 1,000 tons. Of the vessels under 1,000 tons, 61, aggregating 14,297 gross tons, were coasting steamers and tugs, and 80, aggregating 10,670 gross tons, were sailing ships.

The particulars of the 18 steamers above 1,000 tons are as follows:

Names	Type	Gross Tons	I. H. P.	Built at
H. M. S. *Fuso*	Battleship	30,600 (Displ.)	40,000	Kure Naval Dockyard
Fushimi Maru	T. S. Pass. & Cargo	11,757	12,000	Mitsu Bishi Dockyard
Suwa Maru	T. S. Pass. & Cargo	11,757	11,211	Mitsu Bishi Dockyard
Yasaka Maru	T. S. Pass. & Cargo	11,813	10,415	Kawasaki Dockyard
Toyooka Maru	T. S. Cargo	7,630	5,800	Mitsu Bishi Dockyard
Toyohashi Maru	T. S. Cargo	7,500	6,000	Kawasaki Dockyard
Tokuyama Maru	T. S. Cargo	7,500	6,000	Kawasaki Dockyard
Harbin Maru	T. S. Pass. & Cargo	5,500	6,500	Kawasaki Dockyard
Peking Maru	S. S. Cargo	3,181	1,648	Osaka Iron Works
Nanking Maru	S. S. Cargo	3,181	1,824	Osaka Iron Works
Chokyu Maru	S. S. Cargo	2,138	1,150	Uraga Dock Company
Hosan Maru	S. S. Cargo	1,194	833	Osaka Iron Works
Isshin Maru	S. S. Cargo	1,484	1,114	Osaka Iron Works
Naha Maru	S. S. Cargo & Pass.	1,040	1,000	Fujinagata Shipyard
Hakushin Maru	S. S. Cargo	1,536	1,272	Mitsu Bishi Dockyard
Yaeyama Maru	S. S. Pass. & Cargo	1,036	953	Mitsu Bishi Dockyard
Miyako Maru	S. S. Pass. & Cargo	1,013	981	Osaka Iron Works
Michi Maru	S. S. Cargo	1,483	764	Tochiki Shipyard
Total		111,343	124,297	

The most interesting vessel built in 1914 was the battleship *Fuso*, of 30,600 tons displacement, which was launched at the building dock at Kure in March, 1914. This vessel, which is one of the largest and most powerful battleships afloat, carries twelve 14-inch guns in six turrets, all arranged on the centerline of the ship. The vessel will go into commission during the latter part of next year.

In addition to the *Fuso* there are under construction three sister ships, namely the *Yamashiro*, at the Yokosuka Navy Yard, the *Hiuga* at the Mitsu Bishi Dockyard at Nagasaki, and the *Ise* of the Kawasaki Dockyard of Kobe. The propelling machinery of these ships consists of Brown-Curtis turbines and Japanese Admiralty type watertube boilers, with the exception of the *Hiuga*, which is fitted with Parsons turbines. The battle cruiser *Hiyei* was completed last summer and is now engaged in actual service, while her two sister ships, the *Kirishima* and *Haruna*, are now undergoing speed trials at the Mitsu Bishi Dockyard and the Kawasaki Dockyard, respectively.

After the outbreak of the present war, a supplementary budget was passed in the special session of the Diet, held last September, authorizing the construction of ten destroyers of 600 tons displacement and 9,500 indicated horsepower, to be completed in about six months. Contracts for the construction of two of these vessels were placed with the Mitsu Bishi Dockyard, two with the Kawasaki Dockyard, and one each with the Osaka Iron Works and the Uraga Dock Company. The hulls, machinery and equipment of these vessels will be constructed entirely in Japan.

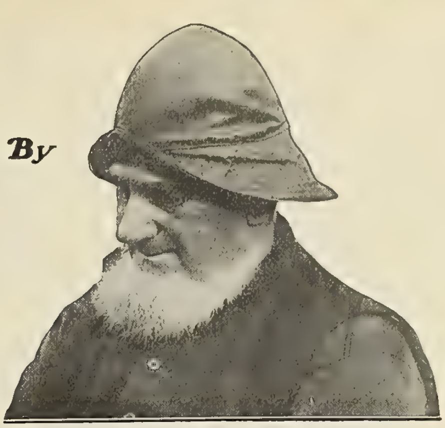
The output of merchant vessels included three 12,000-ton liners, named the *Fushimi Maru, Suwa Maru* and *Yasaka Maru*; three 7,500-ton cargo steamers, one being fitted with geared turbines of 5,800 indicated horsepower; a 5,500-ton passenger steamer, and two cargo steamers of 3,200 tons each, built on the Isherwood system of longitudinal framing. A number of coasting steamers were also launched and there has been considerable activity in building small craft throughout the country.

As regards the new work now in hand, there are two 10,000-ton steamers, one 7,500-ton steamer and many smaller vessels on the stocks at the principal shipyards. There is, however, little prospect for new orders in the immediate future.

Japanese Battle Cruiser *Hiyei*; Displacement, 27,500 Tons; Indicated Horsepower, 64,000

The building of steam trawlers, which was once a very prosperous business in Japan, has practically ceased, owing to the over-production of this type of craft and the gradual decrease in the earning capacity of the fishing industry. On the other hand, however, the adoption of oil motors in small fishing vessels is progressing steadily, there being at present about 3,000 motor fishing vessels scattered throughout Japan. In this way the construction of marine motors has become one of the most important features of the marine engineering industry in Japan.

Economy Talks By "Old Scotch"



Feed Water Heaters and Boiler Circulators

Well, Sir! here I've been talking about how to save in small things on board ship these hard times, and, much to my surprise, and almost disgust, I went aboard two good-sized tugboats right here in New York harbor that didn't have a sign of a feed-water heater on board either of them. I could hardly believe my eyes, and when I asked the chief engineer of one of them why he didn't have such a contraption, he simply shrugged his shoulders and said, "Damfino." I don't know who the superintending engineer was, but his company must either have money to burn, or else they ought to get a new boss engineer.

Of all the ways of saving money right off quick, I don't know of any that is more positive on any kind of a steam vessel, large or small, than an ordinary feed-water heater. By using some of the exhaust steam to heat the feed-water, it's a cinch that you can save at least ten percent of your fuel bills. Besides that, it is simply downright cruelty to boilers to pump in feed-water that isn't heated up to much over 90 or 100 degrees. If you had a pair of horses working for you, and kept filling them up with ice water, you wouldn't expect to get very much work out of them. They might get along for a time, but sooner or later they would get cramps and lay down on the job. Marine boilers get the next thing to cramps when filled with cold water, and express their indignation at such treatment by starting to leak in all their joints.

When you consider that you will save enough fuel in six months on any kind of a job to pay for the installation of a feed-water heater, isn't it a surprising thing that some engineers, even to this day, will refuse to have them put in? I can remember well when these fuel-savers were first put on the market, and it wasn't such a long time ago, either. Like a great many others, I held back about adopting the new-fangled idea, but "Lordy Me!" when I looked into the matter seriously and saw what they would accomplish, I wasn't long in getting on the band wagon and having one installed on my packet. Now, of course, I am like all other converts to anything new, and wonder how anyone can be so stupid as to go without a heater.

Taking it all in all, I believe we marine engineers are about the most conservative bunch of ducks that ever was, anyhow. The great majority of us have now been won over to using feed-water heaters, but there is another apparatus which accomplishes about as good results, that the most of us are still as shy of as a jack-rabbit is of a hound dog. What I have in mind is a good circulating apparatus to warm up the water under the furnaces of our Scotch boilers.

If you hired a man to work for you, and had his head and body wrapped in a warm blanket, while his feet and legs, up to his knees, were standing in ice water, you wouldn't reasonably expect to get very efficient work out of him. Yet we all have been doing practically that same thing with our boilers all our lives.

We have all looked disgusted when the belly seams started to leak and said, "Well, that is one of the worst features of the shell boiler," and never for a moment have considered that it was easy to remedy such conditions. Lately, however, several live wires have patented devices which will keep the water under the furnaces circulating like the water above the furnaces, and even then we stand shy of them. It is only when some of them come along, take us by the back of the neck and absolutely guarantee results, that we will consent to give them a trial. Our own good sense ought to tell us that the temperature can be raised in the bottom of the boiler to practically the temperature of the steam, and we shouldn't need any guarantees. But then we are so timid and shy of new inventions that we have to be coaxed to try one of this particular kind.

Just think what is to be gained by this improved circulation! The shell plates, being heated up uniformly all around the circumference, will forget to leak, the boiler itself will, in nine times out of ten, forget to lift its water, and there is bound to be a small saving in fuel—not very much, but sufficient to make it worth while from that standpoint alone.

A friend of mine, about ten years ago, had a pair of old boilers under his charge which were ticketed to be replaced right off on account of their leaky condition. The company, however, couldn't raise the price just then, so as a sort of a last resort, like trying any old kind of dope on a dying man, they decided to try one of these circulating devices they saw advertised. The result is that the old kettles are still in use, and my friend writes me that they are steaming as well or better now than they ever did in their lives. Of course, boiler builders can't be expected to recommend devices that will keep their work from wearing out and getting along without any repairs, but then the shipowners ought to have a look in occasionally during these hard times.

When we get to using apparatus of this kind, as we all are bound to do, if we have any sense left, then we ought to do another thing that has always struck me funny as to why it isn't always done. That is, to cover the bottoms of the boilers with lagging, the same as the tops. Isn't it foolish, when you think of it, that we haven't done so before? The best reason I could ever think of for not doing so, was that it makes the boilers really and truly Scotch—that is, to clothe their bodies and let their legs go bare.

Yours for economy,

Old Scotch

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT*

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Q.—I understand that fuses are usually labeled for their working load. Can you tell me about how much of an overload it takes to cause them to blow out? L. L.

A.—Fuses are rated at 80 percent of their capacity, so that an overload of 25 percent will cause them to burn out.

Q.—Can you give me the composition of a good Babbit metal suitable for use in marine engine bearings? M. T.

A.—United States Navy specifications require the following: Copper, 3.7 percent; tin, 88.8 percent, and 7.5 percent of the regulus of antimony, all to be fluxed with borax and rosin in the mixing.

Q.—What are considered reasonable steam consumptions for modern triple-expansion engines as are common in merchant ships? What is good for a boiler feed pump? E. McL.

A.—Fifteen pounds per horsepower per hour is a commonly accepted standard for triple expansion marine engines of fair size and operating condensing. Many, however, will better this figure by 10 percent or more. For boiler feed pumps of the reciprocating direct acting type and of good design and construction the steam consumption should be from 1¼ percent to 2 percent of the water pumped for pumps operating at from 200 to 300 pounds per square inch.

Q.—Will you kindly tell me if centrifugal pumps are ever used for boiler feed pumps, and if so, whether it is possible to use them on boilers having pressures as high as 245 pounds? C. P.

A.—Centrifugal pumps of the multi-stage type are now commonly used for feed pumps, and no trouble has been experienced for pressures up to 250 pounds, or even greater. They are usually of from two to four stages and may be motor or turbine driven. The compounding practically consists of connecting several single stage pumps in series, each pump or stage raising the pressure through a moderate range.

Q.—Will you please inform me what the temperature of a smokestack is at forced draft, induced draft and natural draft? J. N.

A.—Theoretically, the best natural chimney draft occurs when the absolute temperature of the hot gases is 25/12th of that of the surrounding air. If the air were at 60 degrees Fahrenheit then the temperature would be $(60 + 460) \times 25/12 = 1{,}085$ degrees absolute, or 625 degrees Fahrenheit. In general, for natural draft, 600 to 700 degrees Fahrenheit are common temperatures. Lower temperatures can be obtained with induced and forced drafts unless the boiler pressures are very high, or unless superheaters are used. 500 to 600 degrees Fahrenheit are common for induced and forced drafts. Higher temperatures are often met with when the grates are forced to high rates of combustion. In such cases the temperature may be 600 to 800 degrees Fahrenheit, or even higher, but these temperatures are undesirable on account of the heat waste.

Q.—We have a 10-kilowatt direct-current electric generating set used for lighting purposes, and I have noticed that the carbon brushes get very hot when the generator is loaded. Can you tell me if this is all right; and if not, what to do to remedy it? E. G.

A.—The heating of commutator carbon brushes to a temperature much higher than the hand can bear is undesirable, and may be due to (1) conduction of heat from some other hotter part of the dynamo, (2) sparking, (3) arcing across the mica insulation of the commutator segments, or (4) imperfect electrical connections between the bushes and the brush holder. No. 1 is a structural or design defect and the operator can do but little to remedy it. It is, however, uncommon. No. 2 is oftentimes present in a sufficient amount to cause heating and yet be scarcely visible. Well-fitted and properly looked-after brushes and a smooth commutator surface will usually take care of this. No. 3 is usually due to the collection of metallic particles over the face of the commutator and the remedy is to clean the commutator thoroughly. No. 4 frequently occurs with carbon brushes. In general, carbon brushes heat more than metallic ones, especially if they do not fit well against the commutator. The remedy is obvious. Carbon brushes should not be depended upon to carry more than 40 amperes per square inch of contact surface.

Q.—I have noticed that steel boilers having high tensile strength, say, 60,000 to 65,000 pounds per square inch, are more susceptible to galvanic action and corrosion than the old iron boilers of 40,000 to 45,000 pounds per square inch tensile strength of former times. Why is this? L. S.

A.—This is a much-discussed question, and it is probable that the tensile strength has no influence upon corrosion, the real factor being the difference in chemical composition, or the difference in process of manufacture between iron and steel. It is a well-established fact that iron, especially as manufactured some years ago, corrodes less easily than steel, although its corrosion varies in different specimens more than in the steel, and this variation is often greater than the difference in corrosion between iron and steel. Of course, when working with a material of lower tensile strength it is necessary to make the parts of greater thickness, and this increased thickness furnishes a larger margin against the corrosive action and consequent longer life. In general, a good, pure metal suffers more than a hard inferior one, and, as steel may be regarded as a particularly good homogeneous iron, it is suggested by some that this accounts for the difference.

Q.—How do you estimate roughly or approximately the pulling power exerted by a winch or windlass? S. M.

A.—From tests which have been made at the Massachusetts Institute of Technology, upon the efficiency of an anchor windlass of large size, the overall efficiency of the unit or the ratio of useful horsepower to indicated horsepower was about 35 percent, so that it is possible that from 30 to 40 percent of the indicated horsepower available at the cylinders is available for actually lifting weights. The indicated horsepower of the cylinders can be determined by the customary calculations for probable

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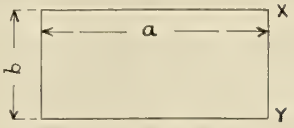
mean effective pressure of engine cylinders. Using this, if the indicated horsepower of the cylinders were 20, we might expect to actually do in one minute $\frac{20}{3} \times 33{,}000$ foot-pounds, a distance of 22 feet in one minute.

Q.—(1) In a flat, rectangular plate firmly secured along all four edges and loaded with a uniform load, what is the tension in the plate in the direction of "a" and of "b" at any section?

(2) In a flat, rectangular plate firmly secured, etc., and loaded with a



Sketch of Flat Plate

uniformly varying load along, say, the "b" axis, i.e., a load of zero at "X" and a maximum at "Y," what would the tension be?

(3) In a flat, rectangular plate supported along all four edges, what would be the tension when loaded as in questions (1) and (2)?

(4) In a circular plate, what would be the tension along the diameter and around the edge when the edge is fixed (1) and loaded with a uniform load (2), a uniformly varying load (3), and when supported and loaded as in (1) and (2)? Draftsman.

A.—In all the questions asked the solution when possible involves the use "in extenso" of the theory of elasticity, and except for some of the cases in which the rules work out to a simple and readily applicable form, "Draftsman" should make use of any of the standard works upon this subject, such as "Theorie der Elastizitat und Festigkeit," by Grashof," or "Applied Mechanics," by Gaetano Lanza. The following are taken from "Design of Steam Boilers and Pressure Vessels," by Haven and Swett:

f = intensity of stress.
$\frac{1}{m}$ = Poisson's ratio.
u = experimental constant
p = load per unit area.
r = radius of plate.
t = thickness.

Answer to Question 1:

$$f = \frac{u}{2}\left(\frac{a^2}{a^2+b^2}\right)\frac{b^2 p}{t^2}.$$

u varies from 9/8 to ¾, according to degree of fixedness of edge. Use $u = ¾$, value for good degree of rigidity.

Answer to Question 2: This is too involved to deal with here. See references.

Answer to Question 3 (a): Use above formula with value of $u = 9/8$, value for entire flexibility.

Answer to Question 4 (a, 1):

$$\text{Center } f = \frac{pr^2}{2t^2} \qquad (\text{using } m = 3)$$

$$\text{Circumference } f = \frac{3pr^2}{4t^2} \qquad \left\{\begin{matrix}\text{using } m = 3 \\ \text{apparent stress}\end{matrix}\right\}$$

Radial direction at circumference

$$f = \frac{3}{4}\left(\frac{m^2-1}{m^2}\right)\frac{pr^2}{t^2} \qquad (\text{true stress})$$

Answer to Question 4 (b, 1):

$$f = \frac{3}{8}\,\frac{(m-1)(3m+1)}{m^2}\,\frac{pr^2}{t^2} \qquad (\text{true})$$

$$f = \frac{5pr^2}{6t^2} \qquad (\text{true, using } m = 3)$$

$$f = \frac{3}{8}\left(\frac{3m+1}{m}\right)\frac{pr^2}{t^2} \qquad (\text{apparent})$$

Q.—Are centrifugal pumps of the high-speed type, such as those direct-connected to turbines, ever used for circulating pumps for condensers? S. S.

A.—High-speed centrifugal pumps, usually turbine driven, have found favor for circulating pumps for shore condensing plants and have been used to a limited extent for marine work. Here, however, the necessity for frequent variations in speed of the circulating water on account of changing injection temperature and the wide range of these changes imposes a condition of speed control which is inimical to efficiency at some speeds. This is probably why the slow-speed steam engine-driven unit is still preferred for this service in many cases.

Q.—Can you tell me if there is any relationship between the temperature of discharge of the circulating water and the vacuum maintained in the condenser; also, is the temperature from the air-pump discharge much affected by changes in vacua? H. L.

A.—The temperature of the discharge water should be a little lower than the temperature of saturated steam corresponding to the vacuum—enough lower to insure condensation but no more, as heat is then thrown away. Desirable temperatures as recommended by R. M. Neilson (Institution of Engineers and Shipbuilders of Scotland, Vol. LIII) are tabulated below:

Pressure, Pounds.	Vacuum 30 Inches, Barometer Inches.	Saturated Steam Temperature, Degrees F.	Economical Outlet Temperature of Water, Degress F.
0.75	28.48	93	88
1.00	27.98	102	94
1.25	27.46	110	100
1.50	26.96	117	105
1.75	26.46	121	110
2.00	25.96	127	114
2.25	25.42	131	117
2.50	24.92	135	120

If temperature close to these given cannot be maintained for the vacua given, there is probably an excessive air leakage into the condenser.

Q.—Will you kindly give me information concerning the probable cause of sparking on the commutator of an electric generator? S. E. C.

A.—The sparking on the commutator may be due to a number of different causes. The commonest ones are perhaps the following:

1. A rough or uneven commutator surface which causes the brushes to jump slightly. This is best remedied by using a fine file on the commutator while the armature is in motion with the field cut out, or by using fine sand paper applied by a block of wood hollowed out to fit the commutator. Care should be taken to remove the sand and copper dust when the job is finished. Emery cloth should never be used. If the surface is very uneven, it may be necessary to remove the armature and turn up the commutator in a lathe.

2. Poor brush contact due to insufficient brush pressure or to poorly fitting brush ends, so that the brush makes contact at but a few points. If the commutator is very foul the ends of the brushes may become dirty and give this effect.

3. Excessive current on account of overload or due to short circuit on the supply mains.

4. A short circuit coil or a broken coil in the armature. This is usually located at one point on the armature—i. e., the commutator in whose segment the trouble lies.

5. Grounds in the armature winding, such as accidental electrical contact between two or more points of the armature conductors.

Q.—Will you kindly enlighten me on the subject of testing steel forgings? I am not very proficient in mathematics and, therefore, do not understand just how the deductions are arrived at. The sample tested was 10 inches overall in length, turned down to .498 inch, the area of cross-section being .1960 square inch. The test piece was punch-marked 2 inches and 4½ inches apart. The piece broke under a tensile stress of 14,500 pounds and broke right in one of the 2-inch punch marks and showed an elongation of 11.5 percent for the 2-inch marks. The 4½-inch punch marks were placed on the 1-inch diameter sections and elongated to 4.83 inches. Can any data be obtained from the 4½-inch

marks? The reduction of area was 29.2 percent, or, reduced diameter, .419 inch. The load per square inch reported was 74,300 pounds. The ultimate strength, 63,900 pounds, and the elastic limit, 12,460 pounds. The fracture was one-half cup silky. The material analysis was carbon, 33 percent; phosphorus, .007; sulphur, .026; manganese, .40; silicon, 1.40. I will appreciate it very much if you will show me how this was worked out, and also if the material is first-class and suitable for marine engines. Will you also kindly inform me of some text-book dealing with the elementary principles? M. C.

A.—No reliable information can be obtained from the 4½-inch punch marks, as the sectional area between them is not constant. As to suitability: Lloyd's requires for steel forgings for marine engines a breaking strength of 28 to 32 tons (long) accompanied by an elongation of not less than 29 and 25 percent, respectively, so that an elongation of but 11.5 percent is entirely insufficient. Moreover, the elastic limit is given as 12,460 pounds. This probably refers to total load and not stress per square inch, in which case the elastic limit is at about 85 percent of the tensile strength, which is abnormally high for material for marine engines. The material comes more nearly in the class of cold-rolled steel axles, as given in the Standard Specifications of the American Society for Testing Materials, 1914, and is entirely unsuitable for the use mentioned. In testing a bar of this sort, the ratio of the lengths between the 2-inch punch marks before and after breaking gives the elongation. The elastic limit is derived by measuring the elongation as each tensile load is applied and plotting a curve of loads on elongations. When the elongations increase faster than the loads, the elastic limit is considered to have been reached. This curve, called a "stress-strain diagram," has its highest point and, therefore, greatest load (in the case of steel) before the breaking point, which accounts for the maximum load of 74,300 pounds per square inch being in excess of the breaking load.

For an elementary treatment of the general question of strength of materials see "Strength of Materials" (a Text-Book for Manual Training Schools), by M. Merriman, or "Text-Book of Mechanics," Volume III, by L. A. Martin, Jr., both published by Wiley & Son, New York. For an excellent elementary book ~~on~~ the testing of specimens and their behavior see "Laboratory Manual of Testing Materials," by Hatt and Scofield, published by McGraw-Hill Book Company, New York.

The Old Navy and the New*

BY WALTER M. MC FARLAND

The momentous change in the personnel of the navy, which resulted from the enactment of the Personnel Law in 1899, marked the development of the old navy into the new. As one who is very proud of having been a member of the old navy for nearly a quarter of a century, I will say at once that, under conditions as they existed, and with the knowledge at the time, the old navy was very efficient. There had been a time in my own early days when conditions were almost disheartening, because we had not been allowed to build a new ship or a new gun for many years. More than a decade, however, before the Personnel Bill, the Congressional policy of intense economy and retrenchment had been modified, so that we began building modern vessels with the guns and other equipment thoroughly up to date. Indeed, in some features, we led the world. All this had a very beneficial effect on the personnel, as supplying an opportunity for the application of the best thought and ability.

It was recognized by everybody, both in the service and out, that the most important feature of the change brought about by the Personnel Law was the absorption of the Engineer Corps, and all its duties, by the Line. It was realized that, for a time, engineering duty would be performed, as before, by those who had specialized in it, but that immediate steps must be taken to make engineering just as much a part of the line officer's training as seamanship, navigation or gunnery. For a time the senior engineers of the large vessels, and fleet engineers of squadrons, continued to be officers who had always been identified with engineering; but after some six or seven years nearly all of these officers came into the class specially charged with shore duty, and all the engineering afloat was performed by officers of the new school. The enthusiasm and professional skill displayed by these young officers are deserving of high praise.

In the new navy efficiency in engineering is not left entirely to the sense of duty of those who have charge of the machinery, but a great many of the younger officers, who have made application for the course, have been given special instruction in designing and advanced theory at Annapolis and at Columbia University. In addition to this, the bureau encourages suggestions from officers, and issues from time to time bulletins giving to the service the benefit of valuable experiments wherever gained. This is of the very greatest value in maintaining high efficiency and enthusiasm. In the friendly competition for the efficiency trophy, engineering counts very high, and I have been told that every officer on the ship is just as keen to see the engineering efficiency high as to attain a high mark in gunnery.

During the administration of that grand old man of engineering, Admiral Melville, we were in the forefront of progress in everything relative to marine machinery. This record has been maintained, and there is every reason to believe that it always will be maintained. We need only mention Diesel engines in the *Maumee,* the mechanical reduction gear on the *Neptune* and the electric reduction gear on the *Jupiter* to realize that nothing which promises improvement is neglected. As for wireless telegraphy, I cannot speak with authority, but I believe that it is generally conceded that our naval installations are leading the world.

Discussion of the new navy thus far has related very largely to the fleet, because, after all, that is the navy; but vessels need overhauling and repairs, and it is sometimes desired to build new ones in our navy yards, so that we naturally come to the consideration of the shore side of duty. Until recently, the chief engineers of the navy yards were officers who had always been identified with engineering. Gradually, however, their places have been filled by line officers trained for general service, and for a long time the subordinates have been officers with such training. Here, too, the record is entirely satisfactory, and shows that the officers of the "new model" are thoroughly competent for all duty which is assigned to them.

There are questions of administration and various other matters of personnel which are still open to improvement. I have been greatly interested in suggestions looking to the incorporation in the line of two of the other corps, and I believe that this would result in great benefit to the service. With all of the officers who have to do with the building and operation of ships members of one homogeneous body, there would be no longer room for any bickering or strife, except that due to personal peculiarities.

* Extracts from an address delivered at the annual banquet of the American Society of Naval Engineers, Washington, D. C., Feb. 20.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries — Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Economy of Coal and Boiler Corrosion*

BY LIEUT. G. J. MEYERS, U. S. N.†

Economy of coal and boiler corrosion are two topics of the day that many marine engineers are desirous of having light shed upon in a practical way. The brief remarks presented are from experience on a battleship for over two years, and show how economy and boiler corrosion are related.

The writer, as chief engineer of a battleship notorious for its excessive coal consumption, had to face the problem of reduction of coal consumption and prevention of boiler corrosion, and at the same time the maintenance of the machinery in such condition as to be ready for any duty called upon. The attaining of the first two objects was thus a tedious task, requiring a great deal of patience.

The boiler plant consists of twelve Babcock & Wilcox boilers furnishing steam for engines developing 20,000 horsepower at full power. The boilers are now eight years old, having been retubed once.

A systematic record of the work undertaken was as follows, each item being pursued to the bitter end:

1. Tightness of baffles and boiler casings.
2. Cleanliness of boilers on water sides and fire sides.
3. Tightness of condensers.

Every baffle was examined for tightness, the method adopted being the simple expedient of holding a light on one side, and carefully examining baffles for chinks and cracks. The horizontal baffles were found to be the worst leakers of CO direct to the uptakes. These were originally built of brick laid together, but not cemented. All broken or chipped bricks were renewed and the baffles covered on top with a layer of vitrifying cement. The cement is examined frequently and repairs effected immediately, if any is found broken off or chinks are found.

Vertical baffles were all realined, distance pieces secured and brought together so as to reveal no cracks or chinks. This is a tedious process, as it requires a great deal of time and careful inspection to see that no chinks are left in the baffle.

The boiler casings are old and the castings for side doors and tube blowing doors were found broken at the corners and along the edges and could not be renewed except at considerable expense. To eliminate leaks, the casings were gone over frequently with a candle, and all air leaks are now plastered over with a plaster of half fire clay and half loose asbestos. This is inspected frequently while steaming, the bucket containing the mixture of clay and asbestos being kept on hand in the firerooms at all times.

After several months of experimental work in cleaning the fire sides of tubes, it was found that for boilers steaming the following method was most effective, as no tube-blowing apparatus was installed in the boilers:

* Awarded first prize in Engineers' Contest for the best letter on engine room experiences.

† Chief Engineer of the United States battleship *Rhode Island.*

(*a*) *Underway.*—A tube-blowing gang of six men was detailed to start work on the steaming boilers at 8 A. M., and to give each boiler a thorough tube blowing with air each day, working until 4.30 P. M. After letting fires die out in boilers, each boiler is given a thorough tube blowing, everything from the smoke pipe down is swept free of soot, and when this is all removed the fireroom is closed, the ash pan and furnace doors opened, one blower started and all loose soot blown up the stack.

(*b*) *At Anchor.*—The tubes are blown in each boiler under steam once a day, and in case of fires dying out the same procedure is followed as already given.

The cleanliness of the water sides of the boilers is possibly the most important part of the proceedings, as it directly involves corrosion. From the experiments of Lyon on boiler corrosion, it is found that corrosion will cease when the boiler water is kept 3 percent alkaline. To effect this result, Navy standard boiler compound is furnished ships of the navy as required. This compound consists of 76 percent of anhydrous sodium carbonate, 10 percent of trisodium phosphate, 1 percent of starch, and 2 percent of tannic acid derived from cutch only. It acts as a cleanser as well as an anti-corrosion agent.

The first step in the cleaning anti-corrosion campaign was to remove from each boiler all handhole plates, back and front, and run through each tube a turbine cleaner, then to wash out thoroughly the boiler with fresh hydrant water, and finally to swab out each tube with rags or burlap dipped into a strong solution of boiler compound. All headers, water legs, and side boxes were scraped and cleaned as thoroughly as possible with scrapers and old table knives.

When the boiler was closed up and filled, six pounds of boiler compound were put in with each ton of water. The compound was mixed in a coal bucket, cleaned and used only for this purpose. About fifty pounds of compound was mixed in a 100-pound coal bucket, boiled thoroughly with a small steam connection from the auxiliary line, shoved under a ¾-inch suction tapped into the auxiliary feed pump suction and sent into the boiler through the auxiliary feed line. After a boiler was filled and the compound injected, the auxiliary feed pump was used to take water from the boiler by the bottom blow line and send it back to the boiler through the auxiliary feed line, thus circulating the compound in the boiler and making the water as uniformly alkaline in all parts of the boiler as possible.

Tests daily of water of all steaming boilers and weekly of water of all boilers are required. Boiler compound is added as required to each boiler, about 15 pounds being necessary for each 1 percent alkalinity.

After each boiler had steamed at low-pressure for about ten days, with daily blow down of 3 inches in the water glass, the fires were died out and the boiler emptied and given another washing out with fresh hydrant water. When filled, compound was put in the boiler as already described. At no time is alkalinity allowed to get below 3 percent. The boiler compound has kept all scale from forming and reduced corrosion to a minimum.

On some boilers, after a considerable period of steaming, it was found that stalactites of boiler compound were forming on the outside of the front handhole plates. After a little investigation, this was found to be due principally

to salty water in the boiler, this result being reached when the water contained 300 grains or over of chlorine to the gallon. It was then found that the next problem to tackle was condensers and boiler feed. Dirty or rusty bearing surfaces for gaskets of handhole plates and dirt in the boiler also caused boiler compound to come through the joints.

All water from air pump discharges is tested daily and from the reserve bottoms weekly for chlorine and, if chlorine gets up to 5 to 8 grains per gallon, the leak is first localized to one condenser. At the first opportunity this condenser has its handhole plates removed, is filled with water, and examined for weeping. Ferrules found weeping are set up. Almost invariably where water from a condenser is found to be only slightly salty, two or three ferrules are found loose, or have dropped out, due to vibration and rolling of the tubes. To tighten a condenser usually has been found to take a day, and sometimes less, and the trouble involved is a small price to pay for absolutely fresh water.

The reserve feed tanks containing fresh water for make-up feed are filled from shore or from water distilled. Every tank of water from the distillers is tested and should not be run into reserve bottoms, if containing over 5 grains of chlorine to the gallon. The same may be said of water received from ashore—it should be tested for chlorine before being taken aboard. Usually make-up feed from the distillers does not exceed two grains of chlorine per gallon of water.

The above three points properly taken care of with the usual work required to keep joints on piping, piston rings, steam slide valves, and piston rod packing tight, have resulted in an actual gain in economy for the five months from July 1 to December 1, 1914, over the previous year of 71 percent.

The following is a description of the water-testing apparatus used and of the method of making tests:

Apparatus

1. Two burettes graduated to 1/10 cc. at 15 degrees C., 50 cc. capacity, for alkalinity and chlorine tests.
2. One white porcelain dish of 200 cc. capacity.
3. One measuring cylinder graduated to 1 cc. at 15 degrees C., 100 cc. capacity.
4. One glass stirring rod and four eye droppers.
5. One glass beaker 150 cc. capacity for pouring solution into burettes, etc.

Chemicals

6. One thousand cc. of one-half normal nitric acid (HNO_3).
7. One hundred cc. methyl orange solution (1/10 gram of methyl orange in 100 cc. of distilled water).
8. Five hundred cc. of normal anhydrous sodium carbonate (anhydrous Na_2CO_3).
9. One thousand cc. nitrate of silver solution (4.101 grams $AgNO_3$ c. p. in 1 liter of distilled water).
10. One hundred cc. potassium chromate solution (1 gram K_2CrO_4 in 100 cc. of distilled water).

Alkalinity Tests

1. Draw a sample of water to be tested into a collecting vessel which has first been washed out with water from which sample is drawn.
2. Fill burette with nitric acid solution. Record reading of scale at surface of solution.
3. Measure 50 cc. of sample of water in cylinder and place in porcelain dish under burette.
4. Drop 2 drops of methyl orange with an eye dropper into sample of water in porcelain dish.
5. From pet cock at bottom of burette, draw nitric acid into sample, stirring continuously with glass rod until sample turns to a faint pink. Close pet cock and read scale at top of solution in burette. The difference between this reading and reading taken in (2) indicates number of cc. of acid required to neutralize the alkali in the sample. Each cc. of difference is equal to 1 percent of alkalinity; that is, if difference is 3.4 cc., the water is 3.4 percent of normal alkaline strength.

Chlorine Tests

6. Make sample in dish neutral by adding sodium carbonate solution until sample just turns yellow. One drop should be sufficient.
7. Replace burette containing nitric acid with burette containing nitrate of silver.
8. Add to the sample four drops of potassium chromate solution with an eye dropper.
9. Read scale at surface of silver nitrate in burette.
10. From pet cock at bottom of burette, draw silver nitrate into sample, stirring continuously with glass rod until sample turns a reddish yellow color throughout. Close pet cock and read scale at top of solution in burette. The difference between this reading and reading in (9) indicates the number of cc. of nitrate of silver required to precipitate all of the chlorine in the sample.
11. With this strength of nitrate of silver solution each cc. used in the 50 cc. sample indicates 1 grain of chlorine to each gallon of the water tested; that is, if the difference in readings is 36 cc., the water contains 36 grains of chlorine to the gallon. If chlorine is known to be more than 50 cc. to the gallon use the following tests:
12. Pour into measuring cylinder 5 cc. of the sample after performing (6).
13. Add to the 5 cc. two drops of potassium chromate with an eye dropper.
14. Then add silver nitrate solution until contents of cylinder turn a reddish yellow color throughout.
15. Read cylinder scale at top of contents. From this subtract 5 and multiply remainder by 10. The result is the number of grains of chlorine per gallon in water tested. Thus, if reading is 45, $(45-5) \times 10 = 400$, and water tested contains 400 grains of chlorine to the gallon.

Interesting Change in Twin Screw Steamer*

BY D. SAWYER †

One of the most interesting jobs I ever took part in was on a twin screw light draft steamer of about 1,200 tons displacement. When built she was fitted out with pipe boilers and four-cylinder triple expansion engines, allowed a steam pressure of 250 pounds and developed on forced draft 3,300 indicated horsepower. She made about 21 miles an hour. Her wheels turned in.

Owing to bad feed water, condenser troubles, etc., the pipe boilers were not at all satisfactory, and when her sister ship was built about eight years later it was decided to install Scotch boilers in the new boat, hence materially reducing the power and speed. Also the engines of the new boat were three-cylinder triple and her wheels turned out.

Soon after the new boat was placed in commission the

* Awarded second prize in the Engineers' Contest for the best letter on engine room experiences.

† Chief Engineer, S. S. *Northland*, the Norfolk and Washington Steamboat Company, Norfolk, Va.

older one was taken off and reboilered, the new boilers being duplicates of those in the new boat.

It should be borne in mind that the two boats were built on the same lines, and after the older one was reboilered they were of approximately the same displacement. Evidently now there was no material difference in the power, as the boilers were identical and the triple expansion engines used the steam generated at about the same ratio of economy; on the older boat, however, the wheels turned in, while on the new one they turned out.

As a matter of fact, in deep water they did make practically the same time, about 18 miles an hour, but in shoal water in which about 25 percent of the run was made, the

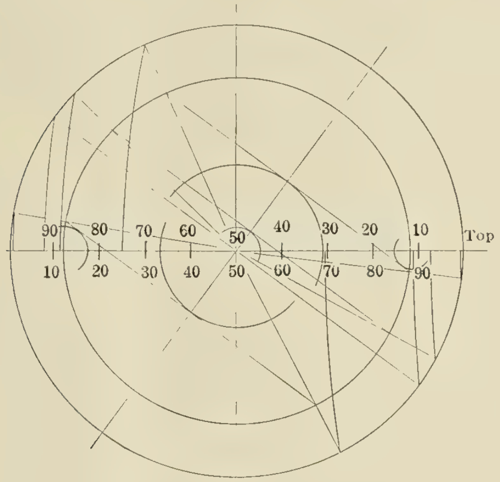


Fig. 1.—Valve Diagram No. 1

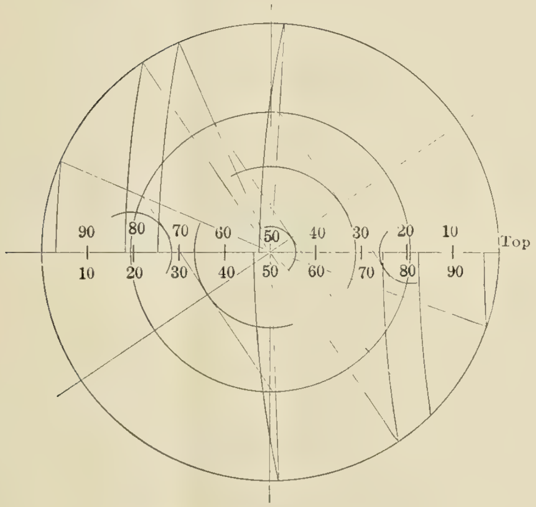


Fig. 2.—Valve Diagram No. 2

new boat made by far the best time. We decided that this was due to the difference in direction of rotation of the wheels and that this could be altered at no great expense. Both boats were run over the same course daily, the new boat at night and the older one on the day run. The run was of about three hours' duration with about six hours lay up and then return. We had her original valve data (I am speaking now of the older boat) and this for the high-pressure engines will be seen by reference to valve diagram No. 1 (see Fig. 1) and corresponding data.

On a trip over one morning we took indicator cards Nos. 1 and 2 on one of the high-pressure engines. (Of course we took cards on all the cylinders, but that is of no interest here.) Card No. 1 was taken with the link "all the way out," and corresponds to valve diagram and data No. 1. Card No. 2 was taken with the link "in three notches," where it had been customary to run it since the reduction in boiler power. This card corresponds to valve diagrams and data No. 2.

As soon as we reached port we disconnected the top ends of all the eccentric rods and reassembled with the rods crossed. While doing this we had three inches cut out of the high-pressure bridle bars, this being necessary now to link her up, as the links would have to stand in the "reverse" position to work ahead, and the slots in the

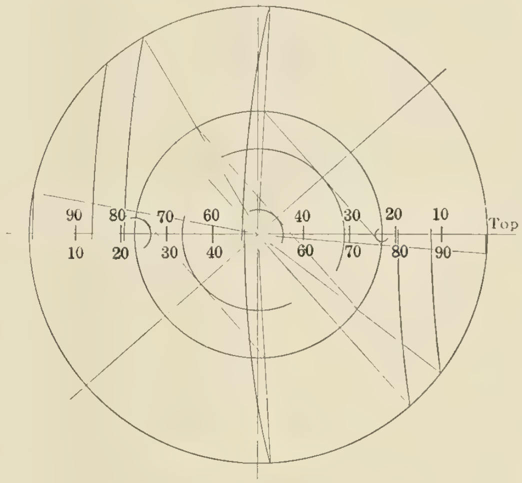


Fig. 3.—Valve Diagram No. 3

rocker arms for linking up were brought nearly vertical and hence useless as a linking up device, but of course the block had to be run in three notches to compensate for what was cut out of the bridle bars when the links were thrown in their original ahead position, which was now the backing "motion." We then started out on the return trip, and on the way over took another set of cards. No. 3 is the high-pressure card of this set and corresponds to diagram and data No. 3. It is clear at a glance that No. 3 card represents a better condition than No. 2.

After this experimental trip we allowed her to run this way for several weeks, when she went to the yard for her semi-annual docking, when we took off the wheels and replaced them on opposite shafts—that is, the starboard wheel on the port shaft and vice versa. We also brought the high-pressure bridle bars back to their original length, and now with the links standing in their original ahead position the wheels turned out and ahead.

Her time was immediately improved in shoal water fully up to our expectations. Taking the whole run, she gained nearly five minutes an hour and the gain was practically all in shoal water. Also there was very great improvement in her handling, considerable time being saved on this account in shifting around the harbor, as she could now be maneuvered with very much greater facility than before. There was no difficulty with the guides, as she was fitted with bar guides, thus having as much wearing surface on one side as the other.

It must be remembered, though, that her engines were built for high speed, and she made something like 21 miles an hour on her trial trip, whereas now she is run at about 18 miles an hour, owing to the reduction in boiler power and increase in displacement, due to the difference between the original pipe boilers and the present Scotch

Valve travel	Position No. 1. Open Rods Full Stroke of Valve 5"		Position No. 2. Open Rods Linked Up 3 Inches 4"		Position No. 3. Crossed Rods Linked Up 3 Inches 3½"	
	Top	Bottom	Top	Bottom	Top	Bottom
Steam Lap (inches)	1 7-32	1 3-32	1 7-32	1 3-32	1 7-32	1 3-32
Exhaust Lap	11-32 Negative	0	11-32 Negative	0	11-32 Negative	0
Angular Advance	37°		Equivalent to 54½°		Equivalent to 42½°	
Steam Lead (inches)	¼	⅜	13-32	17-32	1-16	3-16
Cut-Off (inches)	19½	17⅞	14⅛	12 1-16	14	12
Cut-Off (percent)	.752	.69	.548	.462	.54	.46
Release (inches)	23.04	22.98	20	19 7-16	20 11-16	20 13-16
Release (percent)	.886	.884	.77	.752	.795	.80
Compression (inches)	1.9	2.03	4½	4⅜	3 7-32	3½
Compression (percent)	.073	.078	.17	.168	.123	.13
Steam Opening (inches)	1 9-32	1 13-32	25-32	27-32	17-32	19-32
Exhaust Opening (inches)	Full Ports		Full Port	2	2 1-16	1¾

Piston Stroke, 26 ins.; Connecting Rod, 61¾ ins.; Eccentric Rods, 61¾ ins.; Working Length of Link, 14 ins. Scale of Crank Circle 1½ ins. = 1 ft. Scale of Valve Circle, half size; Port Width, 2¼ ins.

boilers. The engines were fitted with exceptionally large valves and ports, the high-pressure and intermediate valves being 11 inches in diameter and the low-pressure having two each of 12 inches diameter. The cylinder

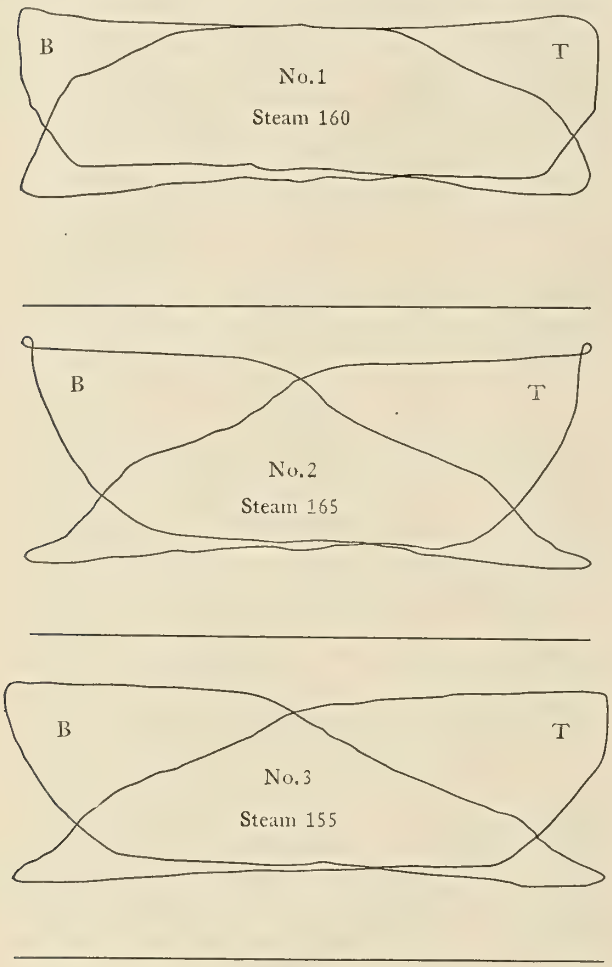


Fig. 4

diameters were 18 inches, 29 inches and 32 inches by 26-inch stroke.

It is no doubt due to the large valve and ports, together with the reduced speed, that the great reduction in valve travel and port opening did not cause wire drawing in the high-pressure cylinder. Of course, the valve movements of the intermediate and low-pressure cylinders were not affected by crossing the rods, as they were not linked up. Under the same conditions the engines developed about the same total indicated horsepower with the rods crossed as before.

Valve diagrams Nos. 2 and 3 were made by the method quoted by Seaton, for which credit is given to Mr. McFarlane Gray. The data formed by the diagrams seem to check up pretty closely with what actually occurred in the engine.

Preventing the Freezing of a Keel Condenser*

BY JOSEPH CHURCH, 2D

The writer is at present employed on a steamer which operates the whole year through, and which is fitted with a keel condenser. Several times during the winter months, or until I found a way to overcome it, the condenser used to freeze and, in order to thaw it out, I had to put about a peck of salt into each end of the condenser and wait from twenty-four to forty-eight hours for it to eat its way through. Strong pickle would have kept it from freezing, but that would have made it necessary to have a large amount of salt on hand, so I set to work to find another way.

I finally decided to try plain sea water, as it never freezes except on the surface. Accordingly, each night before leaving the vessel I inserted the hose in the end of the high-pressure exhaust pipe, and after opening a valve on the other end of the condenser, I pumped in sea water until all the fresh water had been forced out. I have been doing this for two winters and find that it keeps the condenser from freezing. Care must be taken, however, to discharge all the sea water overboard when starting up again.

Warship Construction in Navy Yards

Having read with much interest in your issue under date of December, 1914, the comments entitled "Bids for New Destroyers," I am constrained to say a few words in favor of naval construction in Government navy yards, particularly at Mare Island, California. Having had about six years' experience as a hull draftsman at that station, as well as a number of years in the shipyard and drafting room of a private shipbuilding concern, it would seem that in some measure I may be competent to speak on the subject.

You state that past experience has given ample proof that it is practically impossible for a navy yard to build a warship as cheaply as a private shipyard can build it. This is no sufficient reason why warships should not be constructed at Government navy yards—in fact, it is just the reverse. Admitting that Government-built ships have cost more does not prove that it will be so with the present and future contracts. The estimates and bids from Gov-

* Awarded third prize in the Engineers' Contest for the best letters on engine room experiences.

ernment navy yards are becoming lower, due to more efficient management and up-to-date methods, which also has the effect of keeping the estimates and bids of private contractors down to somewhere near what they ought to be in order to give them a reasonable profit, to which they are justly entitled.

You further state that the cost of repairs on Government-built vessels invariably amounts to a larger sum than the cost of repairs to a contract-built ship. I am not aware that there are any available data that will prove this statement to be true. However, if such be the case, it does not prove that Government work is inferior to that of private shipbuilding plants. The causes which necessitate repairs are varied, and include accident, carelessness, etc., and not necessarily inferior material or workmanship in the original contract. Moreover, a Government-built ship is constructed from the same specifications as those furnished to private contractors, and the specifications must be followed to the letter.

The failure of private shipbuilding firms referred to may have been due to other causes, such as mismanagement, labor troubles, inexperience, etc.

But the statement to which I take particular exception is the one relative to Government employees, in which you say that it is physically impossible for a Government yard, which must depend upon employees inexperienced in construction work, to turn out a naval vessel of the type of the new destroyers at about $200,000 (£41,000) less than it is possible for a private shipyard, with its years of experience and its skilled organization trained in this particular kind of work, to do the same work.

This statement, more especially the part relative to employees and skilled organization, is absolutely untrue and misleading, being without foundation of facts, and is, therefore, an injustice, to say the least. The work done at Mare Island Navy Yard during the last five years, which includes the collier *Jupiter,* the river gunboats *Monocacy* and *Palos,* and the fuel ships *Kanawha* and *Maumee,* will compare favorably both in cost and quality with any of the private shipbuilding concerns of the country. In fact, as shown by the annual report of the Chief of the Bureau of Construction and Repair for the fiscal year 1914, the total cost of the gunboats *Monocacy* and *Palos,* which were built at the Mare Island Navy Yard, transported to Shanghai, China, and there re-erected by contract, was only two-thirds of the bid received from one private shipbuilder f. o. b. shipyard.

These vessels are of light construction, and in some respects the work is similar to that required in the construction of destroyers. The experience gained and results accomplished would seem to indicate that the estimates submitted are worthy of careful consideration by the Navy Department, and it was no surprise to learn that the contract for one destroyer had been awarded to the Mare Island Navy Yard. The present construction officer, Mr. H. M. Gleason, Naval Constructor, U. S. N., who has been in charge of hull construction for several years, and under whose supervision the last four named vessels have been built, is a man of exceptional ability in his profession, and all the way down the line through the drafting room, shops and shipyard can be found men who have had years of experience in the private shipyard with their skilled organization to which you have referred.

Moreover, I may state in this connection that there are no loafers, and none need apply, for if they should be taken on they would have to go to work and keep at it. If there are unskilled and inexperienced employees, or lack of skilled organization in Government navy yards, that fact alone is one of the strongest arguments in favor of building ships in Government navy yards. How can any shipbuilding plant employ and maintain a skilled and efficient force of men without the necessary work to keep them continuously employed?

It is the opinion of the writer, as well as that of many other men more competent to judge, that the Government ought to have under construction all the time naval vessels, so as to keep a large efficient force of men at work in at least two Government navy yards—one on the Atlantic and one on the Pacific coast—so that in case of an emergency the Government would not be at the mercy of private contractors, who charge all they can get in order to pay dividends, or what they consider a fair profit.

U. S. Naval Station, P. F. Peterson.
Olongapo, P. I.

A Peculiar Accident

On January 30, 1914, about 6 P. M., the tug *W. G. Wilmot,* while proceeding up the Mississippi River from New Orleans, La., met with a peculiar accident. Although under full steam, the engine suddenly stopped, and before the steam could be shut off the engines again started with a sudden jar.

When the steam was finally shut off it was found, upon investigation, that the propeller had struck a very large water-soaked cottonwood log, and one of the blades of the 13-foot propeller had embedded itself in the log for a distance of 2 feet after having broken off at the hub.

A line was made fast to the broken blade, and, by means of the capstan, it was pulled on board the vessel.

New Orleans, La. W. R. P.

A Criticism

In the November, 1914, issue of International Marine Engineering, the article on the sternwheel river towboat *Advance* contains two very misleading and incorrect statements which require correction.

First.—It is stated that other boats comparable with the capacity of the *Advance,* 150 feet long by 28 to 32 feet beam, draw 4 feet of water. When such a boat is drawing 4 feet she will have approximately 250 tons of fuel on board or, in round numbers, a supply for 250 hours of running time. On the other hand, the *Advance* has 40 tons of oil fuel, a supply for approximately 80 hours of running time.

Second.—Again, the writer of the article says: "In a boat with 'Western River Boilers,' safety is neglected altogether, service is considered only in a limited way, etc." This is the veriest rot. The Roberts type boiler on the *Advance* has its upper shell built under the U. S. marine requirements on a supposed factor of safety of 6. Every Western river boiler is built under like specifications. The *Advance* boiler has not been in commission sufficiently long to entitle it to a reputation for reliable service. Other similar boilers have signally failed and have been replaced by Western river boilers, greatly to the benefit of the service.

The *Advance* has very good propelling machinery, but no better than other boats using the same design, of which there are a number.

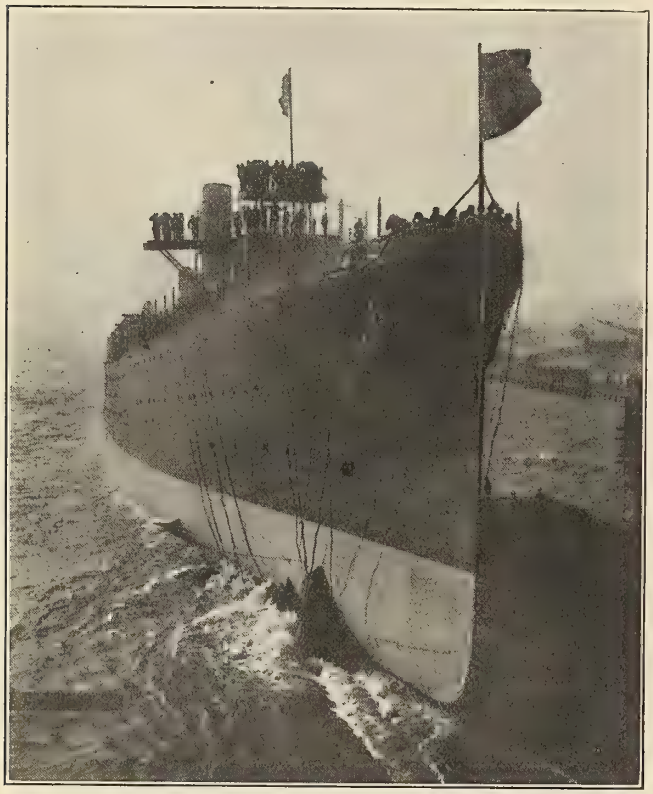
Chicago, Ill. Jno. M. Sweeney.

Annual Meeting of the Society of Naval Architects and Marine Engineer.—The next annual meeting of the Society of Naval Architects and Marine Engineers will be held on Thursday and Friday, Nov. 18 and 19, 1915, at the Engineering Societies' building, 29 West Thirty-ninth street, New York City. The annual banquet of the society will be held on Friday evening, Nov. 19, at the Waldorf-Astoria Hotel.

Recent Launches

The lumber steamer *William O'Brien,* described in our last issue, built by the New York Shipbuilding Company, Camden, N. J., from designs by Edward S. Hough, naval architect and marine engineer, of San Francisco, Cal., for the Carpenter-O'Brien Company, New York, was successfully launched Feb. 27. The vessel is 361 feet 9 inches long between perpendiculars; 51 feet beam molded, 27 feet depth molded with a load draft of 21 feet 6 inches. Her gross tonnage is 5,535 and she is propelled by a triple-expansion engine of about 2,200 indicated horsepower designed to give a speed at sea of 11 knots.

On March 4 the New York Shipbuilding Company also launched the United States destroyer tender *Melville,*



Launch of the *Melville*

which is of 7,150 tons displacement, 400 feet long, 54 feet 3 inches beam and 36 feet 3 inches depth with a draft of 20 feet. The propelling machinery, designed to give the vessel a speed of 15 knots, consists of two Parsons turbines turning a single screw through reduction gearing, steam being supplied by two Babcock & Wilcox watertube boilers. The vessel is especially equipped to perform the duties of a supply depot, repair shop and escort to torpedo boat destroyer flotillas, and is armed with eight 5-inch rapid-fire guns.

At the yards of Messrs. Verdon & Co., West New Brighton, N. Y., the steam lighter *Robert L. Stevens,* designed by Cox & Stevens, naval architects, New York, for the Rock Plaster Manufacturing Company, New York, was launched on March 10. The lighter is 97 feet long overall, 28 feet 6 inches beam and 10 feet depth of hold with a draft of 9 feet 6 inches. The hull is of wood and so designed that a normal cargo of 175 tons can be carried on deck. Propulsion is by a single-cylinder reciprocating engine.

The battleship *Pennsylvania,* of 31,400 tons displacement, was launched at the yards of the Newport News

Launch of the *William O'Brien*

Shipbuilding & Dry Dock Company, March 16. The sponsor was Miss Elizabeth Kolb, of Germantown, Pa. The *Pennsylvania* has a length of 608 feet between perpendiculars; a beam of 97 feet; a normal draft of 28 feet 10 inches, and a speed of 21 knots. Propulsion is by a four-shaft arrangement of improved Curtis turbines designed to develop a total of 32,000 shaft horsepower at 220 revolutions per minute. In addition to the main high- and low-pressure turbines, the engine installation includes high- and low-pressure cruising turbines connected to the outboard shafts by clutches and actuating the shafts through reduction gearing. Steam is supplied by 12 oil-fired watertube boilers. The main battery consists of twelve 14-inch guns mounted in four triple turrets on the centerline of the ship.

Lloyd's Shipbuilding Report.—Statistical tables issued by Lloyd's Register of Shipping for the year 1914 showed that the total addition of steam tonnage to the Register of the United Kingdom during 1914 has been 1,542,353 gross tons. For sailing tonnage, the figures were 16,919 gross tons, making in all 1,559,272 gross tons. The gross deduction of steam tonnage from the register amounts to 1,080,246 tons, and of sailing tonnage, 74,396 tons, making in all a deduction of 1,154,642 tons. On the whole, during 1914 the number of steamers on the official register of the United Kingdom has increased by 252 and the tonnage by 462,107 tons, while the number of sailing vessels has decreased by 133 and the tonnage by 57,477 tons. The total number of vessels on the register has, therefore, increased by 119 and the total tonnage by 404,630 tons during the year.

Marine Articles in the Engineering Press

Reports of Scientific Investigations Covering Marine Engineering Problems—Brief Descriptions of New Vessels and Machinery

Oil Fuel as Applied to Marine Boilers.—By A. J. Walker. A prize essay giving a thoroughly illustrated description of the various arrangements for burning oil under marine boilers. 7 illustrations. 2,130 words.—*Transactions of the Institute of Marine Engineers,* November, 1914.

The Future of British Engineering and Shipbuilding.—By E. W. Frazer Smith. A brief review with data showing the development of engineering in Great Britain, emphasizing the tendency toward progress or retrogression in the various branches at the present time. 3 illustrations. 6,800 words.—Paper read before the *North-East Coast Institution of Engineers and Shipbuilders,* February 26.

Experiments on the Influence of Indicator Connecting Pipes.—By Thomas B. Morley, B. Sc. The investigation was carried out to endeavor to find out whether the arrangements commonly used for attaching indicators to the engine cylinders are responsible for measurable errors or not. The conclusion is that on the whole, unless in abnormal cases, indicator diagrams are not subject to any appreciable error due to the influence of connecting pipes. 4 illustrations. 2,570 words.—*Transactions of the Institution of Engineers and Shipbuilders in Scotland,* February.

The Progress of Reform in the Engineer Branch of H. M. Navy.—By D. B. Morison. The author traces out the revolutionary changes in *materiel* in the British Navy which were followed by corresponding reorganization and reforms of the *personnel.* The practical significance of the value of engineering and engineers in naval warfare is emphasized. The reform movement in this direction culminated in the action of the Admiralty on the first of this year in classifying all engineer officers in H. M. Navy as a part of the military branch. The harmony of view and intention now prevailing augurs well for the future of the navy. 6,800 words.—Paper read before the *North-East Coast Institution of Engineers and Shipbuilders,* February 26.

The Improvement of the River Clyde and Harbor of Glasgow, 1873 *to* 1914.—By Sir Thomas Mason. During the last forty-one years the growth in the size of trading vessels on the Clyde has been very great, the tonnage having increased by 325 percent, the length by 56 percent, breadth by 69 percent and draft by 48 percent. Quayage has increased three times, tonnage of goods handled 4½ times and revenue nearly 3½ times. The water area of harbor and docks, which in 1873 was 76 acres, is now 535 acres. During the period under review the capital expenditure on new works and improvements has been $33,700,000 (£6,913,923). The review describes in detail the various improvements embraced by the entire harbor works, including dock construction, dredging equipment, lighting, terminal facilities, etc., during the period of its remarkable growth.—Paper read before the *Institution of Civil Engineers,* March 9.

Some Notes on Heat Transmission and Efficiency of Boilers.—By R. Royds, M. Sc. After carrying out extensive laboratory experiments to investigate the subject of heat transmission, the author turned his attention to similar investigations on full-sized boilers, so that the results could be compared with those obtained with laboratory apparatus. It was found that the results obtained from various boilers agreed fairly well with the laboratory experiments, and that, while the rate of heat transmission between the gases and water did not appear to be influenced greatly by the temperature of the gases, it would seem that the diameter of the tubes, or the hydraulic mean depth of the gas passage, had an appreciable influence. It is suggested from the results of the boiler tests that one of the most important problems affecting the efficiency of a boiler at high rates of working are the efficient combustion of the fuel. 27 illustrations. 12,500 words.—*Transactions of the Institution of Engineers and Shipbuilders in Scotland,* February.

U. S. S. New York.—By Harrison B. Gregory. A detailed description of the twin-screw battleship *New York,* fitted with reciprocating engines and designed for a speed of 21 knots at 27,000 tons displacement with the engines developing 28,100 indicated horsepower. The vessel was built at the Brooklyn Navy Yard, and is 565 feet long on the waterline with a molded beam of 94 feet 10⅛ inches, a molded depth of 48 feet 8⅛ inches. The draft to the load waterline, corresponding to a displacement of 27,000 tons, is 28 feet 5⅜ inches. The two main engines are of the four-cylinder triple-expansion type with cylinders 39, 63 and 83 inches diameter with a stroke of 48 inches, driving propellers 18 feet 8¼ inches diameter, 19 feet 11 9/16 inches pitch, turning outboard. Steam is supplied at a pressure of 295 pounds per square inch by fourteen Babcock & Wilcox watertube boilers with a total heating surface of 62,213 square feet, a superheating surface of 3,267 square feet and a grate area of 1,554 square feet. Complete details of the hull and main and auxiliary machinery are given, together with the principal results obtained on trial. 5 illustrations. 19,200 words.—*Journal of the American Society of Naval Engineers,* February.

The Governing of Marine Engines and High Speed Auxiliaries.—By R. J. Walker. The fact that it is practically impossible to effectively control by hand the engine speed in a ship in heavy weather, even if "linking-up" is resorted to, has turned the attention of engineers to the question of providing some means of doing this automatically. The impossibility of ever obtaining in marine work the fineness in governing common on stationary engines is obvious. For a marine engine, the ideal governor would be one which would anticipate the subsidence of the water from the ship's stern and cut off the steam or alter the cut-off of the valves before any racing could take place, and also work with enough flexibility to insure that the amount of steam cut off would be in exact proportion to the decrease of load on the propeller, thus keeping the engine speed constant. To show how far the actual results of invention up to the present time have approached this ideal, the author describes in detail practically all known types of marine engine governors, dividing them into two classes—those which act on a variable expansion gear, and vary the speed of the engines by

altering the cut-off of the valves, and those which throttle the steam at the point of admission to the high-pressure valve casing, thus directly varying the amount of steam which actually enters the engine. 5 illustrations. 3,900 words.—*Transactions of the Institute of Marine Engineers,* November, 1914.

Michell Thrust Blocks for the S. S. Ciudad de Buenos Aires.—A comprehensive description, fully illustrated with detailed drawings, of the Michell thrust block constructed by Messrs. Cammell, Laird & Company, Ltd., Birkenhead, for installation on a 6,000-ton twin-screw, geared-turbine steamer developing about 2,625 horsepower per shaft. The shaft diameter is 9 inches and the revolutions at full speed 260 per minute. 5 illustrations. 800 words.—*Engineering,* December 18.

The Institute of Marine Engineers.—In describing the new building on Tower Hill of the Institute of Marine Engineers, which was inaugurated by the president of the society in January, the opportunity is taken to discuss the president's address and point out the special services which this institute provides. The institute differs materially from most other technical organizations in Great Britain, as it aims to include in its membership, primarily, sea-going engineers, and, secondarily, engineers whose work may be directly influenced by those responsible for the driving of war and merchant vessels. The intimate association of these two classes of professional men has resulted in much benefit to progress in practical marine engineering. 13 illustrations. 2,700 words.—*Engineering,* January 22.

Deck Loads of Timber.—Apprehension regarding the safety of deck loads of timber does not seem to have been dispelled in spite of the official limitation which has been placed upon the height of load allowed for such cargoes during the winter months. The question is discussed from the standpoint of stability and of possible disasters owing to the lack of judgment in placing and securing the deck load. It is concluded that the most important point to realize at the present time is not so much the height of the deck load as the possibility of securing it properly, and it is believed that this phase of the question should form the subject of any regulations which hereafter may have to be issued. The stability of timber carriers cannot be measured by the heights of their deck loads. Its regulation, it is claimed, must conform to a very much wider scheme that will apply to ships of all types and descriptions. 1,000 words.—*The Engineer,* January 8.

Description of the Repair Plant of the U. S. S. Vestal.—By Lieutenant-Commander L. J. Connolly, U. S. N. The *Vestal,* built originally as a collier for the United States navy, has an over-all length of 465 feet 10 inches, an extreme beam of 60 feet 2½ inches, and a normal displacement of 7,720 tons. Propulsion is by two triple-expansion, three-cylinder engines of 7,500 horsepower, and the speed 14 knots, steam being furnished by six Babcock & Wilcox boilers at 180 pounds working pressure. The conversion of the *Vestal* from a collier to a repair ship, authorized by Congress in 1913, required the installation of decks and galleries in the former cargo holds; the relocation of two of the original four masts, the masts being now so placed as to permit the use of traveling cranes in the shops; the installation of additional electric and pneumatic power and distilling apparatus. A number of structural changes were made. Fresh water tanks were built in which to carry water for the larger crew; the superstructure was extended aft to provide for an optical workshop, a general office and a drafting room. Skylights were built to cover the original cargo hatches, and six cargo ports, three on each side, were cut so as to give light and illumination to the workshops and to facilitate the handling of work delivered alongside the boats. A towing engine was installed aft, so that the ship may take another vessel in tow in case of necessity. A detailed description, well illustrated with photographs, is given of the general storekeepers' store, the machine shop, electric shop, coppersmith shop, pattern-making shop, foundry, carpenter's shop, optical shop, etc., together with a description of the equipment installed for giving prompt repairs to vessels away from repair yards. 25 illustrations. 4,700 words.—*Journal of the American Society of Naval Engineers,* February.

Turbine Electric Propulsion of a Battleship Compared with Other Means.—By Lieutenant-Commander P. W. Foote, U. S. N. In a paper by Captain C. W. Dyson, U. S. N., on "Engineering Progress in the United States Navy," which was read before the Society of Naval Architects and Marine Engineers in November, 1913, it was shown that reciprocating engines were more advantageous for use in battleships in the United States navy than the turbine, in the following characteristics: Greater economy in low speeds, hence greater cruising radius; ease of upkeep of machinery, allowing greater readiness for duty; efficient propellers for maneuvering and high backing power; weight and space; minimum vibration of hull, due to machinery, and steadiness of hull as a gun platform. In the following particulars the reciprocating engine and the turbine were shown to be about equal: Economy at maximum speed when this does not exceed 22 knots; reliability when driven at high powers, and boiler weight and space. The only condition in which the turbine was considered superior to the reciprocating engine was in case the necessary power to be developed was greatly increased from that at present, and if the ordinary cruising speed were made considerably higher than now used. The above characteristics showed good reason why reciprocating engines were preferred to turbines for the battleships *New York, Texas* and *Oklahoma.* Now, however, there are two means for which great merit is claimed by which the speed of the turbine may be reduced and the power transmitted to the propeller with a high efficiency. These two means are mechanical reduction gearing and electrical transmission. The author cites the various cases where these two forms of propulsion have been adopted, pointing out the merits and defects developed. In the author's opinion the data and comparisons thus presented show conclusively that for a battleship the turbine electric-propelling machinery completely outclasses not only the reciprocating engine but all other types of machinery now developed for the purpose, the points of superiority being economy at moderate and low speeds, hence great cruising radius; economy at maximum speed, hence ability to run at highest speeds without exhausting the fuel supply or fire-room force if coal is used; great reliability when driven at maximum speed; facility of control, high backing power, efficient propellers; less weight of machinery and space occupied by it; less boiler weight; less work necessary for care and upkeep, allowing greater radius of duty, and lack of racing of propellers, hence greater ability to steam at high speeds in a heavy sea. After a careful consideration of all the engineering features involved in battleship propulsion, the author fails to find any reason why electric drive should not be utilized on the new United States battleships. 7 illustrations. 9,400 words. —*Journal of the American Society of Naval Engineers,* February.

New Books for the Marine Engineer's Library

New Edition of Seaton and Rounthwaite's Pocketbook of Rules and Tables—Captain Dyson's Chart System for Designing Screw Propellers

Marine Engineering Rules and Tables. Twelfth edition. By A. E. Seaton and H. M. Rounthwaite. Size, 4 by $6\frac{1}{4}$ inches. Pages, 713. Numerous illustrations. New York, 1914: D. Van Nostrand Company. London, 1914: Charles Griffin & Company, Ltd. Price, \$3.50 net.

For over twenty years Seaton and Rounthwaite's Pocketbook of Marine Engineering Rules and Tables has been used by marine engineers throughout the world as a standard reference book for use in the many problems involved in the design, construction and operation of marine machinery. Since the first edition of this Pocketbook was issued in 1893, conditions of ordinary marine engineering have been considerably modified, and the introduction of the turbine and internal combustion engines for the propulsion of ships has added very considerably to the demand for data not included in the early editions of the book. In the present revised and enlarged edition all of the tables have been extended up to and even beyond present practice. The new rules of the Board of Trade, recently issued, and the many modifications of Lloyd's and other registry societies have been embodied. Fresh tables have been added to enable students and others engaged in research work to economize their time. Also much other information not available before will be found generally useful.

The contents of the book include, first, a general treatment of the power and propulsion of ships, giving data on efficiency of marine machinery, engine power measurements, the thermodynamics of steam engineering and the details of reciprocating engines, including data on dimensions, proportions, loads and stresses with details of fittings, etc., for both naval and mercantile practice. This information applies not only to the main engines, shafting and propellers, but also to condensers, pumps, valve gears, valves and auxiliaries. Separate sections deal with steam turbines and internal combustion engines. A considerable portion of the book deals with boilers, giving data on construction, requirements, proportions, efficiency and boiler work. Materials, strength of materials, composition, properties and costs of various metals and numerous other subjects are included. In all, nearly 200 tables are published in the book.

Screw Propellers and Estimation of Power for Propulsion of Ships. By Captain Charles W. Dyson, U. S. N. Vol. I—Text. Size, $5\frac{3}{4}$ by 9 inches. Pages, 142. Illustrations, 24. Vol. II—Atlas. Size, $9\frac{3}{4}$ by $15\frac{1}{2}$ inches. Charts, 32. New York, 1913: John Wiley & Sons, Inc. London, 1913: Chapman & Hall, Ltd. Price, \$7.50, 31/6 net.

For many years Captain Dyson has been associated with that branch of the work of the Bureau of Steam Engineering of the United States Navy which has to do with the design of propellers for naval vessels. His work in this direction has given him exceptional opportunities not only to carry out the design and follow out the performance of screw propellers for many different types of vessels but also to have access to a vast amount of data on propellers not readily available to the layman. His study of the subject began in 1901, when at the request of the late Rear Admiral George W. Melville, at that time engineer-in-chief of the navy, he began the preparation of a paper on the performances of the screw propellers of naval vessels. From time to time papers were published giving the results of his investigations until finally the subject matter of the various papers was arranged for publication in book form.

The theory of propeller design that Captain Dyson sets forth is based on model tank trial curves of model hulls supplied by Rear Admiral David W. Taylor, chief constructor of the United States Navy; Froude's theory of the propeller as developed by S. W. Barnaby, and the data of trials of actual vessels as supplied by the Bureau of Steam Engineering. Barnaby's constants for propeller efficiencies are represented graphically on a chart on which can be plotted from their performances the location of any desired propeller. Many propellers were so plotted by Captain Dyson, and from the results were obtained a sufficient number of factors to enable those factors of propeller design, which directly affect the efficiency, to be so tied together graphically as to render it possible to take from these charts, when the resistance and form of hull of the vessel are known, the necessary factor for use in the determination of the diameter, pitch, projected area, and probable propulsive coefficient that will be obtained, for any desired case. The series of charts thus developed offers a most convenient and readily applicable means of designing propellers that give uniformly good results. When basic hull data of sufficient accuracy are at hand this method can be depended upon to give as good, if not better, results than can be obtained by any other method.

Aside from the description of the development of this method of propeller design and of the use of the charts, the contents of the book cover such subjects as the estimation of power for propulsion, form of blades and blade sections, materials for propellers, the effect caused on performances of propellers by varying the elements of the propellers, cavitation, etc. Problems met with in propeller design are also given, together with forms for computation and a chapter, prepared by Luther D. Lovekin, on the geometry and drafting of propellers. The author is to be congratulated upon the splendid presentation of the subject. The book will be found of inestimable value by all who have to do with the design of screw propellers and the powering of ships.

Handbook of Technical Instruction for Wireless Telegraphists. By J. C. Hawkhead. Size, $5\frac{1}{2}$ by $8\frac{1}{2}$ inches. Pages, 295. Illustrations, 170. London, 1913: The Marconi Press Agency, Ltd. Price, 3/6 net.

This course of instruction has been arranged so that the diligent reader who has gone carefully through it might be qualified to sit for the Postmaster-General's examination for wireless telegraphists. The author has had a practical experience in the operation and construction of all classes of wireless apparatus and stations and the text-book embodies this experience. It will be found very useful to beginners in the science of wireless telegraphy.

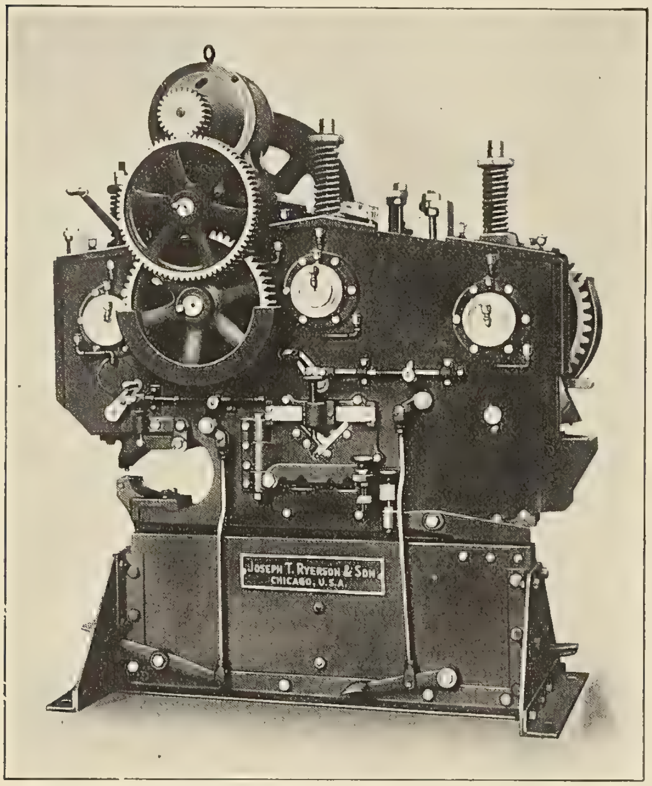
Whale Fishery of New England is the title of a 63-page, paper-bound book issued by the State Street Trust Company, Boston, Mass.

No chapter in American history is more fascinating than the story of the early whaleman, and even the novice cannot read this exceedingly interesting book without realizing this. The story is well told and the illustrations are exceptionally fine, there being forty-two of them, nearly all of which are reproductions of rare old prints. The story is told in such a way that everyone who reads it will not only enjoy it but benefit by it.

ENGINEERING SPECIALTIES

Ryerson Quintuple Combination Punching and Shearing Machine

The quintuple combination punching and shearing machine illustrated, which has just been placed on the market by Joseph T. Ryerson & Son, Chicago, embodies five metal working machines in one, handling the punching, shearing, coping and notching work on plates, bars, angles, tees, beams and channels without the necessity of interchanging any attachments for the various operations. The



Five Metal Working Machines Embodied in One

punch or bar cutter and splitting shear can be operated independently by automatic clutches which can be thrown in either by hand or by foot levers.

The frame of the plate shear consists of a solid steel offset shear body which permits the cutting of plates of any width or length. A hold-down which can be adjusted vertically and horizontally is provided with the splitting shear.

By an important arrangement of the bar-cutting device, angles, tees and round and square bars can be cut without any change of shear blades. The particular blade for shearing angles and tee-bars is of right angle shape which, it is claimed, produces a perfect cut without bending even the smallest and lightest sections. The shear blades are fastened to the slide in a simple manner, and are made in four pieces instead of one. Stationary blades are mounted on a hinged steel frame which enables the easy removal and grinding for any part of the shearing blades. Adjustable hold-downs permit the cutting of various materials to a perfect right angle and a special arrangement is furnished with the machine which allows the cutting of angles in miter up to 45 degrees.

The punching machine is equipped with a standard architectural jaw permitting the punching of I-beams, channels and similar sections in flange and web. A patented centering device is furnished with each machine, allowing the centering of the punch to the full length of the stroke of the plunger. A universal hold-down takes care of stripping any material to be punched.

In the coping and notching machine the heavy head of the splitting shear is provided with an extension to receive the die block for coping and notching work. This die block is of rectangular shape, permitting not only the standard coping of light I-beams and channels, but also the notching of angles, tees, Z-bars and other shapes.

The combination machine is equipped with steel gears with cut teeth throughout and can be furnished either for belt or motor drive. All gears are well covered with cast guards so as to insure safety and to conform to state laws for the protection of workmen. The machine is manufactured in four different sizes, the smallest weighing 3,000 pounds and requiring from 2 to 3 horsepower for operation, and the largest weighing 25,000 pounds and requiring 10 to 15 horsepower for operation.

Universal Line of Life Preservers

The demand for increased safety at sea has resulted in not only bringing out improvements in the structure of vessels and lifeboats, but also in drawing attention to the great need for more efficient life preservers. The life preserver is the last resort between the vessel and possible drowning when a vessel sinks and when the disaster is sudden the preserver is sometimes the only chance for saving life. Lord Mersey's investigation into the loss of the *Empress of Ireland* brought out the fact that many lives that should in all reason have been saved were lost through the inefficiency of the ordinary life belts, in that the head of the wearer was permitted to fall into the

Universal Ilanasilk Mattress Used as a Raft

water before the persons were picked up by the rescuing boats. The rescuers expected to find live people, but were astounded to find the bodies hanging limply in life belts with heads submerged and bodies well above the surface. Since Lord Mersey's return to London, the subject of providing more efficient life preservers has been continually before the marine officers of the Board of Trade. On January 8 the Universal type of life preservers used in the U. S. Navy and invented by Lieut. S. P. Edmonds, U. S. Coast Guard, retired, was officially adopted by the British Board of Trade, after presentation by Messrs. Cox, McCuen & Co., Baltic House, London.

These life preservers are filled with Ilanasilk, manu-

factured from prime Java Kapok with special processes by the Robinson-Roders Company, of Newark, N. J., and are now used extensively by the United States Navy, the United States Coast Guard and other marine services. The United States Steamboat Inspection Service also has them under consideration for approval. The Universal

Universal Ilanasilk Mattresses, Pillows and Life Preservers in Action

Life Line includes life preserver pillows which are excellent for the bunks, as well as most efficient life preservers; ship life preservers that can be stored in the same spaces as present cork life belts; life-saving mattresses which are most comfortable and sanitary and may be quickly joined into rafts of any size; boat cushions, art fancy cushions, etc. Each is provided with an inspector's tag showing its recognized use as life preserver.

The underlying principle of these life preservers is their efficiency in holding the wearer's head out of water even when exhausted or unconscious, thus overcoming the fatal defect of preservers otherwise designed. Ilanasilk is the result of many years of development under patented processes. By careful tests the quality is maintained at the high degree necessary for reliable and efficient life preservers.

The Robinson-Roders Company was recently awarded the Exposition Gold Medal of the International Exposition of Safety at the Grand Central Palace, New York, for the development of Ilanasilk and the manufacture of Universal Life Saving Equipments. Lieut. Edmonds was awarded the Special Gold Medal at the same time. The company has also received the award of a medal by the American Institute of New York City.

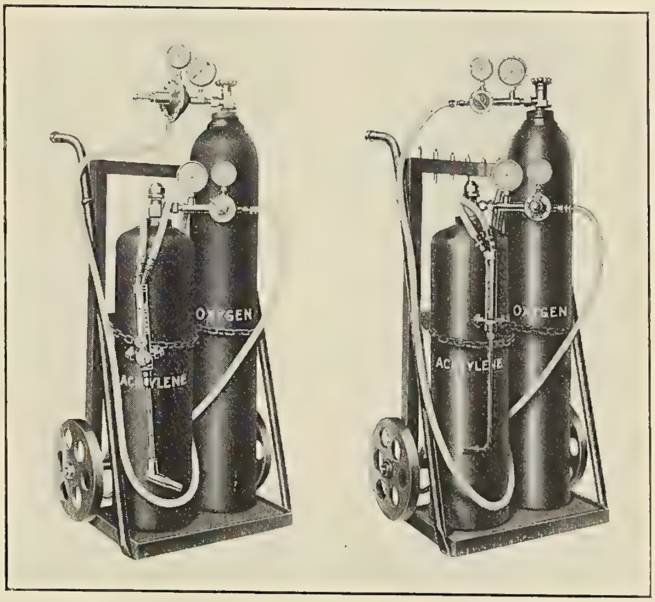
Imperial Oxy-Acetylene Equipment

Oxy-acetylene welding and cutting equipment, possessing some new exclusive features, has recently been placed on the market by the Imperial Brass Manufacturing Company, 1204 West Harrison street, Chicago, Ill. For the safe, efficient, economical and continuous operation of oxy-acetylene equipment two vital points are necessary, namely: (1) Thorough and uniform mixing of the two gases employed, and (2) close and accurate regulation of both volume and velocity of the gases delivered to the mixing chamber of the torch, and ability to maintain a sudden fixed pressure under continuous operating conditions, as well as to control a wide range of pressures called for by the various requirements of service. These features, it is claimed, have been attained in "Imperial" welding and cutting equipment.

A new principle is used for mixing the oxygen with the acetylene. Before entering the mixing chamber of the torch the oxygen under high velocity passes through a spiral groove which imparts to it a whirling motion. The whirling motion of the oxygen, it is claimed, causes it to mix thoroughly with the acetylene, with the result that a uniform mixture is obtained before the gases reach the combustion point. In this way a saving of oxygen is obtained, together with an increased intensity of the welding flame and greater efficiency in cutting.

"Imperial" welding and cutting torches are fitted with interchangeable tips to cover all ranges of work within the limits of the process. The needle valves permit a fine adjustment and are located so that the operator can make any desired adjustment of the flame with the hand that holds the torch, making it unnecessary to lay aside the welding stick. Due to the thorough mixing and accurate regulation of the gases, the welding flame generated is a long, white, incandescent jet free from carbons and oxides. The cutting flame is a very closely confined and accurately proportioned jet designed to make a clean, quick, narrow cut with a minimum consumption of gas.

"Imperial" regulators, it is claimed, deliver an absolutely constant pre-determined volume and velocity of gas

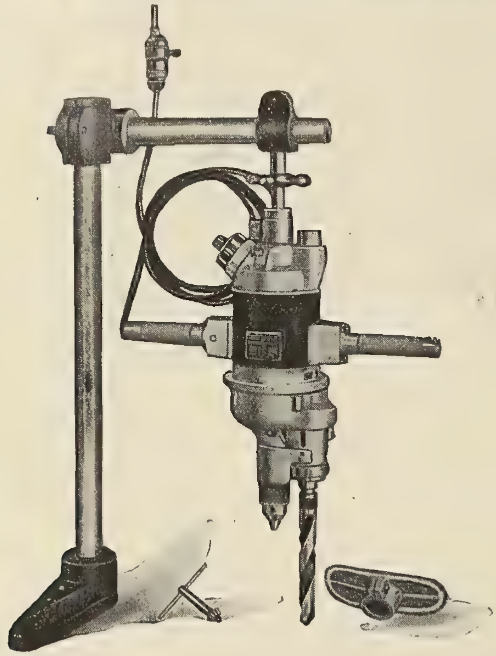


Cutting Equipment Welding Equipment

to the torch and the movement of the valve with relation to the valve seat is limited in such a way as to prevent cutting of the seat, thus insuring long life. In cutting operations under high-pressure "Imperial" regulators will automatically shut off in an emergency.

Stow Two-Spindle Drill

The Stow Manufacturing Company, Binghamton, N. Y., has placed on the market a two-spindle drill particularly adapted to heavy work such as would be required in machine shops, railroad shops, shipyards and large industrial plants. One spindle is fitted with a Jacobs chuck taking



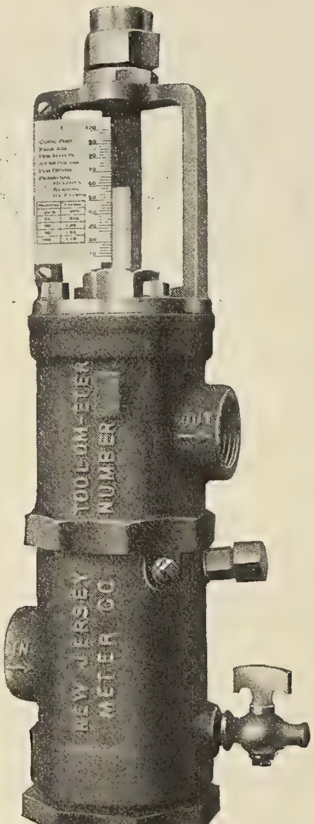
S. S. drills up to ½ inch, running at a speed of 450 revolutions per minute. The second spindle takes M. T. drills up to ¾ inch, operating at a speed of 225 revolutions per minute. The drill is furnished complete with a breast plate and screw feed and will drill holes up to a 1-inch diameter in cast iron.

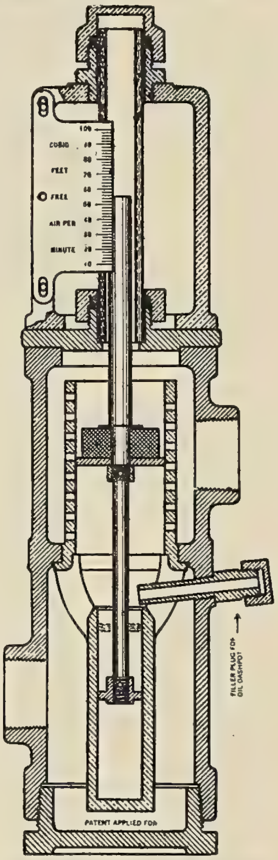
This tool is claimed to be the only two-speed, two-spindle drill on the market, and among the special advantages claimed for it are greater power for heavy drilling from the large spindle and the ease with which either spindle can be reversed, which will be found a great advantage in light tapping, etc. The tool is operated by electricity and, as shown by the illustration, can be readily attached to an ordinary socket.

The Tool-Om-Eter

The Tool-Om-Eter, which has just been placed on the market by the New Jersey Meter Company, Plainfield, N. J., is an instrument for the measurement of air used by pneumatic tools. The meter is so constructed that it shows direct on a scale in cubic feet of free air per minute the flow of air in a pipe or hose. Reference to the sectional drawing will show that there is only one moving element consisting of a weighted piston in the upper or metering cylinder, a small piston in the oil dash-pot cylinder and a rod joining the two pistons and extending upward, where it moves freely without contact inside the sight glass at the top of the meter. This moving element floats on air and is, consequently, frictionless and non-wearing. The rod rises and falls with the pistons, so that its height in the sight glass corresponds exactly to the position of the piston in the metering cylinder. The scale plate mounted against the outside of the sight glass permits reading the exact height of the top end of the rod.

The meter operates in accordance with the well-known law that the volume of a definite compressed fluid, or gas, flowing under small constant head through multiple orifices of the same shape and size is directly proportional to the number of orifices exposed to the flow. It can be seen from the sectional drawing that the air enters at the lower left-hand opening into the chamber surrounding the dash-pot cylinder and passes through ported openings into the interior of the meter cylinder, the wall of which is drilled with a large number of small, accurately reamed holes uniformly spaced. To pass to the





outlet chamber the air lifts the piston and exposes some of these holes to the flow. A small head, or difference of pressure, is established between the interior of the cylinder and the outlet chamber, the pressure difference amounting to only a few ounces per square inch, being fixed by the exact weight of the moving elements and the area of the piston on which the difference of pressure acts. The moving element rises until the weight is exactly supported by the difference in pressure. The pistons and rod are then floating in static balance in a position corresponding exactly to the volume of air flowing, the number of holes exposed and the height of the top of the rod in the sight glass.

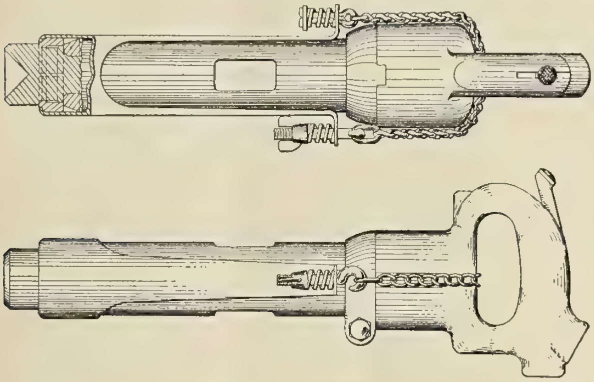
An accurate and easily handled instrument of this sort is especially useful for comparing the economy of different makes of compressed air tools and for maintaining efficiency at a maximum by knowing how much air such tools take when new and after use, and before and after repairing, adjusting or putting in new parts. While practical men can judge the work performed by pneumatic tools, they are unable to judge when the air consumption of individual tools is excessive. A tool may work fairly well, even though the rated air consumption may be exceeded 100 percent or more. The Tool-Om-Eter, it is claimed, will detect and measure any leakage in air lines,

valves, hose, cocks, etc., and determine the net volume of actual air produced by compressors for comparison with a nominal rating or displacement, and, therefore, show whether the machines are operating efficiently or not.

These meters are manufactured in two sizes, one known as the Tool-Om-Eter, of 10 to 100 feet capacity with 1-inch openings, which is recommended for most small tools, such as chipping and riveting hammers and drills, rated by manufacturers at not over 60 feet per minute when new, and another size styled the "Drill-Om-Eter," of from 50 to 300 feet capacity with 2-inch openings for large drilling machines, motors, air lifts, compressors, etc.

Safety Rivet Set Retainer

The George Oldham & Son Company of Frankford, Philadelphia, Pa., manufacturers of pneumatic tools and appliances, have recently placed on the market a safety rivet set retainer which is a decided step in advance in



the "Safety First" movement. The details of the device are clearly shown in the illustration. One of the chief advantages claimed for it is its flexibility, as it can be used on a pneumatic hammer of any make. The retainer weighs 2 pounds.

A New Line of Cutting Tool Holders

J. H. Williams & Co., Brooklyn, N. Y., has placed on the market a complete line of metal-cutting tool holders, the distinctive feature of which is a cam lock for holding the cutting tools. This cam lock, shown in Fig. 1, provides a rapid and convenient adjustment and offers many

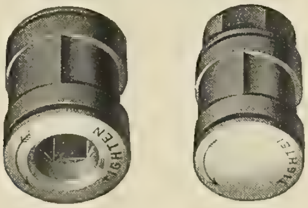


Fig. 1.—"Agrippa" Cam Locks

distinctive advantages over old-style set-screw fastening types. It is claimed that the cam lock provides an increase of 75 percent in the holding efficiency. A small swing of a wrench, approximately 30 degrees, brings the lock into full and positive engagement from a loose fit and vice versa. Both countersunk and hexagonal nut type of cams are provided. It is obvious that this cam type of lock tends to eliminate the frequent damages that occur from twisting off a set-screw head or other holding device.

The cam lock is applied to a number of different metal-cutting tool holders, a few of which are illustrated on this page. Fig. 2 shows the Williams "Agrippa" turning tool holder furnished with either the countersunk or hexagonal nut cam lock. The cam fastener offers full freedom for operation without removal from the tool post and imposes no obstruction to cutting facilities. Fig. 3 shows the Williams "Agrippa" boring tool holder on which a universal cap affords a means for holding all intermediate size of rounds, hexagonal or octagon rods or bars within the limits of its capacity without the use of bushings, shims or other fillers. Two tightening nuts or screws are

Fig. 2.—Turning Tool Holders

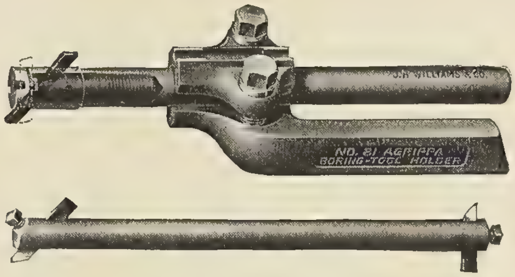


Fig. 3.—Boring Tool Holder and Boring Bar

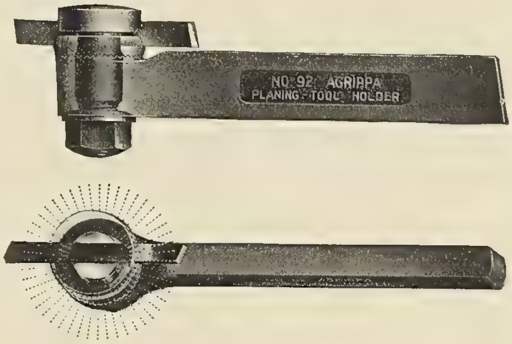


Fig. 4.—Planing Tool Holder

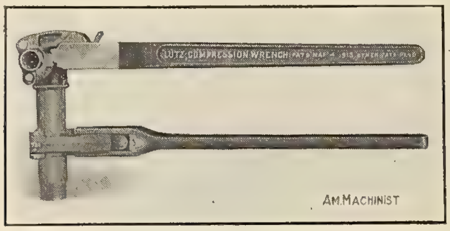
provided to secure greater rigidity and to divide the strain rather than apply it to a single bolt. On the boring bar a universal sleeve is used, making it suitable for either straight or angle cutters without the use of any additional parts.

Fig. 4 shows the Williams "Agrippa" planing tool holder, which has 28 adjustments as compared with seven in the standard tools commonly used. It will be noted that there are 28 rotating serrations corresponding to similar ones in the washer, or adjustment ring. This ring is hardened in order to prevent wearing down of the cutter seat. The locking nut has a hemispherical seat which allows the nut to adjust its seat in line with the strain, thus eliminating side strains in the bolts.

A complete line of cutters is provided for each different holder and for each special purpose.

Lutz Compression Wrench

The Lutz compression wrench, manufactured by the Lutz-Webster Engineering Company, Inc., Philadelphia, Pa., is a universal tool which, it is claimed, can be applied to almost any job which confronts the machinist, boiler maker, steam fitter, engineer or manufacturer. Its construction and operation are clearly shown in the illustration.



It is evident that it will be especially useful for driving studs, taps, reamers, drills, etc., and for the adjustment or installation of pump and valve rods, pins, shafts, bolts, pipe fittings and the like.

Manufacturers of the Harris Valveless Diesel Type Engine

The Southwark Foundry & Machine Company, Philadelphia, Pa., manufacturers of steam turbines, electric generators, air compressors, pumps, condensers and hydraulic presses, has secured the exclusive United States license to manufacture the Harris valveless Diesel type oil engine, which was described in our September, 1914, issue, and which will hereafter be known as the Southwark-Harris valveless engine. The engine will be built in sizes from 75 to 1,000 brake horsepower for both marine and stationary service. Leonard B. Harris, the inventor of the engine, will be consulting engineer and naval architect for the company, and J. P. Johnstown will have charge of the oil engine sales.

A Correction

We are informed by the National Tube Company, Pittsburg, Pa., that the statement published on page 140 of our March issue, which reads in part as follows, "The Worth Brothers-Coatesville Rolling Mill Company, Coatesville, Pa., which holds the unique position of being the only tube manufacturer that can supply itself with basic open-hearth steel skelp for tube manufacture . . . ," is incorrect for the reason that the National Tube Company has for a number of years used basic open-hearth steel in the manufacture of boiler tubes, and this material is still used by them for this purpose. They have also used this material for a number of years in the manufacture of both lap-welded boiler tubes and pipe, and also in the manufacture of seamless tubes from ore to the finished product. It should be understood, therefore, that the National Tube Company was the first tube manufacturer to use basic open-hearth steel in the manufacture of boiler tubes, and has continuously used this material up to the present time.

Personal

William Rigney has been appointed assistant engineer of the Southern Pacific steamer *Chalmette*.

P. H. Cox, a well-known marine engineer of Paducah, Ky., has started a "jitney line" of cars at Paducah.

James Cross, of New Orleans, La., has been appointed first assistant engineer on the ocean-going tug *Pan-American*.

F. Gouner, of New Orleans, La., has been appointed second assistant engineer on the ocean-going tug *Charles W. Morse*.

Charles Castle, formerly employed on barge canal work at Fultonville, N. Y., has been appointed chief engineer of the tug *William H. Baldwin*.

James Faas, formerly with the Randerson Dredging Company, has been appointed chief engineer of the Y. M. C. A. building, Albany, N. Y.

Edward Burns, formerly machinist at the U. S. Arsenal at Watervliet, N. Y., has been appointed chief engineer of the New York State tug *Amsterdam*.

E. Perry has been appointed first assistant engineer of the American tank steamer *Louisiana*. J. A. Jones is second assistant engineer of this vessel.

James La Coy has been appointed first assistant engineer of the tug *William H. Kinch*, of the Great Lakes Dredge & Dock Company, Albany, N. Y.

Martin Bronk, of New Baltimore, N. Y., has been engaged as consulting mechanical engineer for the U. S. Government plant at the Troy, N. Y., dam.

Frank Carney, formerly chief engineer of the steam yacht *Chippewa*, of Cedar Hill, N. Y., has resigned his position to enter business at Castleton, N. Y.

Glenville Brown, formerly chief engineer of the tug *Florence*, has been placed in charge of the plant of the Skinner & Arnold Machine Works, Albany, N. Y.

W. J. Chandler, of Paducah, Ky., second mate on the steamer *Alabama*, has been appointed chief mate of the steamer *Bald Eagle*, which recently left Paducah for St. Louis, Mo.

John Knauer, of New Orleans, La., has been appointed chief engineer of the steam schooner *Francis T. Hyde*. Joseph Turner has been appointed assistant engineer on this vessel.

James Hayes, formerly chief engineer of the tug *Lydia* of the Fulton Construction Company, New York, has been appointed chief engineer of U. S. *No. 16* at the Troy, N. Y., dam.

Burton Colvin, formerly chief engineer of the steamer *Augustus Phillips*, which was burned recently at Athens, N. Y., has secured an appointment as chief engineer of the tug *Clinton*.

Charles R. Ziegler has been appointed chief engineer of the hydraulic dredge *Mohawk* engaged in New York State barge canal work. Mr. Ziegler was formerly chief engineer of various Hudson River steamboats.

Charles Jackson, of St. Louis, Mo., has been appointed chief engineer of the river steamer *Kentucky*, which left Paducah, Ky., March 6, to enter the Calhoun County trade out of St. Louis. Eugene Bates is second engineer of this vessel.

Captain R. C. McMahon has succeeded Harry Rodgers as master of the river steamer *Alabama* in Paducah, Ky. Conway Gordon is second mate of the *Alabama*. Harry Rodgers, formerly master of this vessel, is now serving on the steamer *Kentucky*.

Charles H. Hughes, naval architect and marine engineer, 82 Beaver street, New York, is engaged in compiling a book for shipping men which contains practical data on ship design and construction with sections on marine insurance and chartering.

W. J. G. Hudson, manager of the freight department of the Anchor Steamship Line, was presented with a gold watch on March 13 by the office staff of the line in New York in celebration of his completion of fifty years of service in the company's employ.

Ambrose Van Wie, formerly first assistant engineer of the towboat *William H. Kinch,* has been appointed chief engineer of the towboat *M. A. Knapp,* of the Great Lakes Dredge & Dock Company, Albany, N. Y. Arthur Lamphere is first assistant engineer of the *M. A. Knapp.*

J. L. Western, of Paducah, Ky., has been appointed chief engineer of the Burlington Railroad Company's steamer *North Star,* which left Paducah, Ky., recently bound for Memphis, Tenn., and Kansas City, Mo., where the vessel will be used in the completion of a bridge across the Missouri River. J. W. Hovious, also of Paducah, Ky., is second engineer of the *North Star.*

Morris John Lenney, one of the two warrant officers recently appointed ensigns in the United States Navy, has been ordered to the U. S. S. *Brooklyn* at Boston, Mass. Mr. Lenney was born in Warren, Ohio, on August 3, 1884. He served his apprenticeship in the machine shop of the Peerless Electric Company, of Warren, and was later employed by various machine and engineering companies, finally enlisting in the United States Navy as machinist's mate on September 11, 1905. He won steady promotion, until on December 31, 1908, he was warranted a machinist, in which grade he served three years on board the *Missouri* and two years at the Portsmouth Navy Yard as assistant to the shop superintendent and boiler inspector of that yard. He was commissioned ensign in January of this year, after having served nine years and four months in the Navy.

In its last session Congress passed a bill extending its thanks to and authorizing the promotion of members of the United States Army, Navy and Public Health Service who participated in the construction of the Panama Canal. Colonel George W. Goethals and Surgeon-General William C. Gorgas have been promoted to the rank of Major-General. Colonel H. F. Hodges and Lieutenant-Colonel William L. Sibert have been promoted to the rank of Brigadier-General and Commander H. H. Rousseau, U. S. N., to Captain.

Obituary

J. R. Andrews, president of the Hyde Windlass Company, Bath, Me., one of the most widely known men in the United States among shipbuilders and ship owners, died suddenly of apoplexy March 25 in New York City.

August Mietz, of New York, manufacturer of the Mietz & Weiss oil and gas engines, died recently, aged 80. Mr. Mietz was born in Germany, but came to the United States when he was 21 years old. The firm of Mietz & Weiss was founded about 15 years ago, but recently has been carried on under the name of its founder, August Mietz.

Harrison B. Moore, long identified with harbor transportation in New York City, died at his winter home in Florida on March 4 at the age of seventy-three. Mr. Moore was an enthusiastic yachtsman and was well known in marine circles in the port of New York. After his retirement from active business several years ago, his interests in marine machinery and dry-docking at Erie Basin, Brooklyn, were looked after by his sons Jonathan and Harrison B. Moore, Jr.

Joseph Hallet, chairman of the Council of the Institute of Marine Engineers, died February 9, aged fifty-five years. Mr. Hallet served a five-years' apprenticeship as an engineer in the locomotive and marine department of the London, Brighton & South Coast Railway Works at Brighton, afterward entering the employment of Messrs. J. & G. Renney, where he was engaged in the construction of machinery for important naval vessels. Later Mr. Hallet engaged in business as a consulting marine engineer.

Charles W. Hogan, vice-president of Thomas Hogan & Sons, one of the largest stevedoring firms of New York City, died on March 1 in Provincetown, Bahama Islands, aged fifty-six years. Mr. Hogan was born in Liverpool, coming to the United States when young. After graduating from St. John's School at Manlius, N. Y., he entered the shipping and stevedoring firm founded by his father and continued in that business until his retirement a few years ago. Mr. Hogan was director in a number of large steamship companies.

Frederick Winslow Taylor, famous for his development and application of the science of shop organization and management, and for his invention with Maunsel White, of the Taylor-White high-speed metal-cutting steels, died of pneumonia in Philadelphia on March 21. Mr. Taylor was born in Germantown, Pa., in 1856. In 1878 he entered the employ of the Midvale Steel Company as a laborer and six years later became its chief engineer. In later life, as a consulting engineer, Mr. Taylor's influence in the engineering and industrial world became far-reaching. He was a past president of the American Society of Mechanical Engineers.

George Lawley, of Boston, Mass., head of the famous yacht and shipbuilding firm bearing his name, died February 27, aged ninety-two years. Mr. Lawley was born in London and came to the United States in 1851. Three years later he established a shipyard in East Boston, moving the plant to Scituate, Mass., in 1866. The original South Boston yard was founded in 1874, and it was there that the cup defenders *Puritan* and *Mayflower* and many other famous yachts and sea-going vessels were built. In 1890 the business was incorporated and Mr. Lawley retired from active management.

Charles C. Scott, chairman of Scott's Shipbuilding & Engineering Company, Ltd., Greenock, died February 11 at Halkshill, Largs, Ayrshire, aged forty-eight years. Mr. Scott was educated in the South of England, afterwards studying at Fettes College, Edinburgh, and the Edinburgh University. He served his apprenticeship as an engineer at the Messrs. Scott's Greenock works and was appointed assistant engine-works manager in 1890, becoming assistant general manager in 1900. Upon the death of his father, in 1903, he became one of the managing directors, and in 1905 he was elected chairman of the company. Mr. Scott was past-president of the Clyde Shipbuilders' Association and of the North-West Engineering Trades Employers' Association. He was also a member of the Institution of Naval Architects, of the Institution of Engineers & Shipbuilders in Scotland and of the Committee of the British Corporation for the Survey and Registry of Shipping.

SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

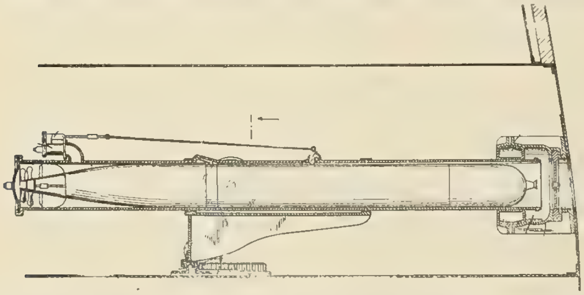
American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,110,410. BULKHEAD-DOOR. HORACE H. THAYER, JR., OF WILMINGTON, DEL.

Claim 1.—In a door for partitions, a partition having an opening providing a door-way, two doors closing the door-way and inclosing between them a space, and means connected with said space to regulate the air pressure therein. Ten claims.

1,122,700. APPARATUS FOR LAUNCHING TORPEDOES. GREGORY C. DAVISON, OF QUINCY, MASSACHUSETTS.

Claim 1.—The combination with a ship's hull having an aperture therein below the water line, of a torpedo tube mounted wholly within said hull and for angular movement about a point adjacent said aperture



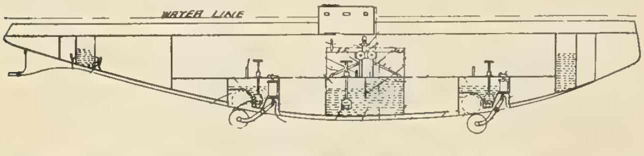
and provided with a yieldable retaining device adapted to be overcome and movement of said tube effected by an issuing torpedo diverted from its course. Four claims.

1,122,782. VESSEL. ALEXANDER McDOUGALL AND ALEXANDER MILLER McDOUGALL, OF DULUTH, MINNESOTA.

Claim 1.—A vessel comprising a hull, vertically removable superstructures at one or both ends of the hull and a depressed working deck supporting means for controlling the vessel whereby said means do not project above the upper deck of the vessel. Twelve claims.

1,123,762. BUOYANCY-REGULATING APPARATUS FOR SUBMARINE BOATS. SIMON LAKE, OF MILFORD, CONN., ASSIGNOR TO LAKE TORPEDO BOAT COMPANY OF MAINE, OF BRIDGEPORT, CONN., A CORPORATION OF MAINE.

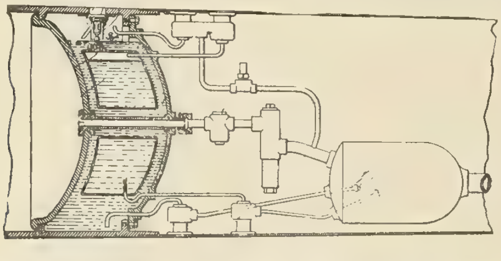
Claim 9.—A submarine or submersible boat, having a central main ballast tank, forward and after ballast tanks, and forward and after trimming tanks, compartments arranged in said main ballast tank in open



communication therewith at their lower ends, one of said compartments having its center of volume arranged in substantially vertical alinement with the centers of gravity and buoyancy of the boat when the boat is on an even keel, means for admitting water ballast to said tanks, and means for excluding water from one of said compartments in the main ballast tank whereby to cause the boat to rise and sink on an even keel. Ten claims.

1,125,979. AUTOMOBILE TORPEDO. WILLIAM DIETER, OF NEW YORK, N. Y., ASSIGNOR TO E. W. BLISS COMPANY, OF BROOKLYN, NEW YORK, A CORPORATION OF WEST VIRGINIA.

Claim 1.—An automobile torpedo having a compressed air reservoir, a pressure reducer, an air heater, and a liquid tank receiving compressed air, and a liquid tank receiving compressed air and communi-



cating with the air heater, combined with means for excluding sea water from such tank and for venting any leakage of air therefrom, such means adapted to close upon the admission of compressed air thereto. Five claims.

1,116,956. AUTOMATIC MEANS FOR LOWERING LIFE-BOATS. RICHARD TJADER, OF NEW YORK, N. Y.

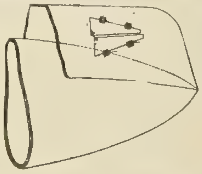
Claim 1.—In automatic means for lowering life-boats, the combination with stationary standards, base and bracing means for said standards, a pair of davit arms including elliptical supports adapted to roll upon said base members, each of said arms constituting a straight extension of a radial edge of its curved support, means to support a boat normally upon the upper ends of said arms, the arms and their supports being so arranged as to be held normally in unstable position whereby when the boat is released the arms will swing outwardly and downwardly automatically, and means to secure the boat keel in normal fixed position. Nine claims.

1,113,257. METHOD AND MEANS FOR AUTOMATICALLY APPLYING DIFFERENTIAL AIR PRESSURE TO COMPARTMENTS OF SHIPS. FRANK JULIAN SPRAGUE AND FRANK DESMOND SPRAGUE, OF NEW YORK, N. Y.

Claim 1.—The combination with the fluid tight compartments of a vessel, of means for supplying compressed air to the several compartments, and reversibly operative means capable of effecting automatic differentiation of the air pressures therein in accordance with their respective distances from an injured compartment. Thirty-five claims.

1,125,567. DIVING-RUDDER FOR SUBMARINE VESSELS. CESARE LAURENTI, OF SPEZIA, ITALY, ASSIGNOR TO SOCIETA FIAT SAN GIORGIO, OF SPEZIA, ITALY.

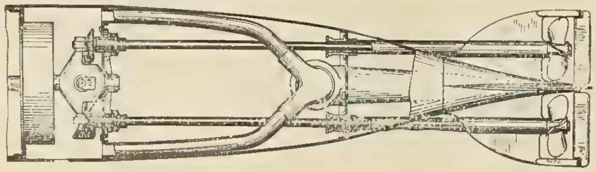
Claim 4.—A boat having depth controlling rudders on each side thereof, said rudders being arranged in pairs on each side of the hull and having axes of rotation substantially in the plane of the side of the hull, and adapted to lie flat against the same, one rudder in each pair



having its axis of rotation upwardly inclined and the other rudder in each pair having its axis of rotation downwardly inclined, whereby, when extended, said rudders present oppositely inclined planes to the water, and means for operating said rudders, said means being adapted to turn together rudders on both sides of the boat having similar inclination of their axes of rotation. Five claims.

1,126,183. TURBINE-DRIVEN TORPEDO. GREGORY CALDWELL DAVISON, OF NEW LONDON, CONN., ASSIGNOR TO ELECTRIC BOAT COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 1.—In an automobile torpedo, the combination of oppositely revolving turbine rotors arranged in tandem, oppositely revolving propeller shafts arranged symmetrically on opposite sides of the axis of



the torpedo, and intermeshing reduction gearing having kinetic symmetry and arranged to establish diving connection between said rotors and said shafts and maintain synchronous rotation of said shafts. Seven claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

24,379/1913. IMPROVEMENTS IN LIFE SAVING AND SALVAGE APPLICATION ON SHIPS. L. TABULO, 22 VALMAR ROAD, DENMARK HILL, LONDON.

Apparatus for transferring persons and goods from one ship to another, or from ship to shore, consists in the combination of a traveler, hauling ropes attached to said traveler, a cableway for said traveler spanning the distance between the transferring vessel and the receiving vessel and kept taut by means of a weight attached to one or both of its ends passed overboard. A hoisting and lowering apparatus provided on said traveler by means of which the persons to be saved can be raised from the deck of the transferring vessel to a position immediately below the traveler and subsequently lowered at the further end of the cabling to the receiving vessel.

23,514/1913. AN IMPROVED "AHEAD" OR "ASTERN" INDICATOR FOR MARINE ENGINES. C. EDINGTON, 34 MUNRO ROAD, JORDANHILL, GLASGOW.

The invention consists in an electrically operated engine indicator having two pointers, one to indicate "ahead" and the other "astern" connected, respectively, by a wheel and cord arrangement to, and directly actuated by, the coves of two solenoids, one or the other of which is energized according as the reversing engine or gear is operated to cause the engine to go ahead or astern. If it is desired to indicate the engine speed, or the revolutions, the one or the other solenoid is intermittently energized, by means of a make-and-break arrangement, to cause the one or the other pointer, according to the position of the reversing engine on gear, to vibrate synchronously with the movements of a moving part of the engine or the propeller shaft.

6,303/1914. IMPROVEMENTS IN APPARATUS FOR INDICATING THE QUANTITY OF WATER IN THE HOLD OF SHIPS, TANKS OF FLOATING DOCKS AND ELSEWHERE. R. G. WEYLL, OF RUA LAURINDO RABELLO, 73 RIO DE JANEIRO, BRAZIL.

According to the invention, the readings are automatically taken from a voltmeter or other indicating apparatus controlled by the electrical part of a transmitting apparatus comprising a balanced float which operates through a chain and sprocket wheel, a screwed spindle carrying the contact maker connecting with a contact rod and with the insulated terminals of a series of resistances, a current generator being included in the circuit.

International Marine Engineering

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An Important Proposal A committee of engineers, representing national and local professional engineering societies, recently submitted to the New York State Constitutional Convention, now in session, suggestions relating to changes in the State Constitution. The recommendations offered proposed the creation of a department of engineering and public works and a department of public utilities, both to be headed by commissioners appointed for long terms, among whom should be well qualified representatives of the engineering profession. These recommendations were offered in the belief that few functions of government are of greater importance than the administration of public works and the regulation of public utilities, both of which embrace great undertakings intimately connected with the prosperity, health and comfort of the people. Few will deny that the farther public works and public utilities are removed from the influence of politics the better for the community. The same might be said, however, with even greater emphasis, of the control of marine and shipping matters by the national government.

Oil Engines for Commercial Boats The article which we publish elsewhere in this issue, on the use of oil engines, ought to attract more than passing attention. For years much has been published regarding marine Diesel engines, and many engines of this type, averaging over a thousand horsepower, have been installed. Some have operated successfully, while others have not come up to expectations and have been replaced by steam power. In general, judging by repeat orders, the four-cycle engine has been far more successful than any type of two-cycle engine thus far developed, in spite of the predictions made by well qualified engineers a few years ago. The manner in which the Diesel type of engine has been promoted by speculators need not concern us, but it is worth while to consider this type of engine from an engineering point of view.

Their very complicated mechanism cannot be denied, and that the excessively high-pressures and temperatures have led to troubles in operation goes without saying. Perhaps one of the most important considerations of all, however, has been the initial cost which, in most cases, has been far above the initial cost of steam plants of similar powers. Probably the high initial cost, together with the doubts of continued reliability and low cost of operation, has done more to prevent the general use of the Diesel type of engine than anything else.

In the engine described these objections seem to have been very largely overcome. The design is simple. Starting, reversing or stopping is apparently as easily accomplished as with an ordinary reciprocating engine, and, judging by the figures given, the economy of operation is exceptionally low. These factors, of course, are all important to the owners of small commercial boats. Generally speaking, the first cost of the steam plants for small commercial boats is in the neighborhood of $50 (£10 10s) per horsepower. In the case of the Diesel type of engine described, the initial cost is approximately the same, and, furthermore, a smaller operating force can be used, and the cost of fuel consumption as compared with coal for a steam plant is in the ratio of about 1 to 10.

With the foregoing in mind it seems that there is an excellent opportunity for the profitable operation of small commercial boats equipped with the Diesel type of engine from port to port, or from landing to landing, where the standby losses are an important consideration, provided the continued low cost of operation of the oil engines can be assured.

Emergency Generating Sets The requirements of modern marine practice for emergency lighting and wireless service on board ship have brought about the development of a type of electric generating sets not hitherto required in the marine field. The necessity for providing a reliable source of electric energy by means of an independent plant isolated from the main power plant, and located well above the full-load waterline, has naturally led manufacturers to the adoption of internal combustion engine generating sets for this purpose. The use of internal combustion engine-driven sets on ship board involves no problems which have not already been satisfactorily solved, and, for the most part, the units are reliable, economical and well adapted for this service.

The installation of auxiliary sets, however, suggests

the possibility of using such plants for other than purely emergency purposes. Where the generating capacity of the main plant in the engine room is only sufficient to meet the ordinary demands for electric current, any excess that may be temporarily needed can be supplied by the emergency set, thereby avoiding the subjection of the main power plant to overloads and their consequent dangers. By installing an emergency generating set of suitable capacity, additions to the original electrical equipment of the ship may be made without adding to the original plant, or, if the original plant consists of duplicate units, one generator could be replaced by an emergency set of suitable capacity, thereby lowering the first cost of the power plant and yet retaining all the features necessary for adequate electric service under both normal and emergency conditions.

From an engineering standpoint, there is no reason for limiting the service rendered by internal combustion engine-driven generating sets, as such units are now so carefully designed that their economy is very satisfactory and a high thermal efficiency can be maintained at partial loads as well as at full load. Under normal conditions there is no difficulty in inter-connecting the main and the emergency sets so that the operation of motors, lights and wireless outfit can be secured either from the main or emergency sets, or from both.

The Classing of American Vessels

A letter from one of the most prominent men in the shipbuilding business in the United States compliments International Marine Engineering on the stand it has taken on the subject of classing vessels built with American money in American shipyards. He writes: "I am very much of the opinion that we should do this very important work ourselves in this country, and, it seems to me, that the essential points to be borne in mind are that the administrative officers of such a society should have the confidence of the underwriters, the technical staff should have the confidence of the shipbuilders, and the rules should be up-to-date and scientific. . . . The reasons for classing our ships in the United States are manifold, but the principal ones with which I am concerned are the saving of time and the preventing of discrimination."

Recently contracts have been placed with American shipbuilders for over forty large vessels, and plans have already been passed for fifteen or more vessels which will undoubtedly be built in the near future. As far as we have been able to learn, every one of these vessels is classed outside of the United States, although possibly two or three may have double classification. The Standard Oil Company of New Jersey has three large ships under construction that are included under this foreign classification; so are the two ships for the Standard Oil Company of New York. The Coastwise Transportation Company of Boston is building six ships under foreign classification; Crowell & Thurlow, of Boston, two; the Luckenbach Steamship Company, one; the New York & Porto Rico Steamship Company, one; the Gulf Refining Company, one; the Anglo-Saxon Petroleum Company, two; the American-Hawaiian Steamship Company, three; A. H. Bull & Co., three; the Munson Steamship Company, one; W. R. Grace & Co., one; the Texas Company, two, and there are several other vessels that have foreign instead of domestic classification. So far as we have been able to learn, practically every one of the fifteen or more vessels reported as about to be contracted for is to be classed across the ocean. The companies that contemplate building these ships include the Ward Line, which is reported to be in the market for four ships.

Surely, under such conditions, the time has arrived for shipbuilders, shipowners, naval architects and other people in the United States who are interested in the subject of classing vessels to get together on the basis referred to by the correspondent above quoted.

A Case of Misplaced Confidence

It is only rarely, we believe, that cause for complaint, similar to that made in the following communication, is found:

"British shipping papers have from time to time called attention to cases where gentlemen representing insurance companies as surveyors, and otherwise, have utilized the influence arising from that position to recommend articles in which they were interested, such as paints, oils, ship chandlery and other goods, to the captains and inspectors of vessels which they were surveying on behalf of underwriters.

"Several cases have arisen where surveyors have been put to the alternative of giving up the one or the other of their connections, for if it is true that no man can serve two masters, that saying applies more forcibly to such cases than perhaps to any other. Unfortunately, foreign insurance and classification societies have not always sufficient work to have an exclusive surveyor representing them at any particular port, and are therefore forced to employ representatives who also have other business interests. Such cases, however, lead to many complaints, and are apt to be the cause of 'jobbery' and injury to the interests of the shipowner.

"Underwriters and classification societies who are faced with the necessity of appointing a representative under such conditions, should make a point of inquiring into the business connections which the prospective surveyor may have, and should make an invariable practice of appointing no one whose other interests or connections are apt to interfere with the impartial discharge of his duties. It is, however, for the surveyors themselves who are placed in such positions to draw the line between their different interests and to fill their positions with the discrimination and uprightness to which their employers are entitled at their hands."

Our correspondent is probably fully justified in calling attention to the state of affairs implied by his communi-

cation, but we doubt if the average man qualified to exercise the offices of representative or surveyor of a foreign insurance company or classification society would stoop to the betrayal of the confidence imposed upon him by his employers in influencing his clients in the purchase of supplies. If such is the case, both the employer and the surveyor are to blame, and the results are bound to be disastrous to both. The sooner such conditions are eliminated the better for all concerned.

The American Society of Marine Draftsmen

Organized to promote the general welfare of marine draftsmen professionally, intellectually and socially, and to cultivate the highest standard of professional ethics among them, the American Society of Marine Draftsmen is fast winning an enviable place among the professional societies in the United States. Its membership is divided into branches, each branch consisting of the draftsmen either from a single shipyard, or, where several yards are located in the same or nearby cities, from a group of shipyards. The general management of the society is vested in an annual convention, consisting of delegates from the branches, and an executive committee consisting of the national officers, and one committeeman elected each year. The present membership numbers several hundred and is divided into twelve branches composed of draftsmen from practically every shipyard on the Atlantic coast and also one yard on the Pacific coast. Additional branches are now being organized, and in the near future practically every shipbuilding district will be fully represented in this organization.

The object of the society was well outlined in an address made by J. Emile Schmeltzer, president of the society, at the annual banquet recently held in New York. On this point he stated: "The object of the society is to unite the marine draftsmen and to promote their welfare socially, intellectually and professionally. That word 'unite' means friendship, union, mutuality, a binding together—co-operation. It implies action, a concurrent striving together for the attaining of certain objects. Of this co-operation is born fellowship. This organization lifts this fellowship from a mere casual acquaintance to an intimacy and a brotherhood that make for courage, sanity and success. It also lifts its members to a higher plane of professional proficiency. The various shipbuilding companies realize this, and it is now customary for them, when in need of men, to write to the society, asking us to furnish them men of certain stated qualifications."

As to the success of the society, Mr. Schmeltzer stated that it has created harmony and good feeling where petty jealousies and prejudice formerly existed, with the consequent increase in efficiency which is the inevitable result of harmonious feeling among its individual members. It was his sincere belief that the society had not only broadened its members' horizon along intellectual lines by association and by the reading of technical papers before its various branches, but that in the near future it would bring to the marine draftsmen that recognition which is justly their due.

While opinions may differ as to the most desirable qualifications which a marine draftsman should possess, nevertheless it is interesting to note the points which were summarized by Mr. Luther D. Lovekin, chief engineer of the New York Shipbuilding Company, in his remarks on "Marine Draftsmen" given at the society's annual banquet: "The points to which consideration is given by the officers of large shipyards when they are looking for the proper man to fill a vacancy," he said, "are usually: First. Is he an able designer? Second. Has he the necessary engineering or architectural ability? Third. Has he executive ability? Fourth. Is he of steady habits? Fifth. Has he honesty of purpose and a good character?"

With these points in mind the marine draftsman should realize the necessity for the years of hard work at comparatively small financial returns before he can expect promotion to the engineering staff. As Mr. Lovekin pointed out, experience and hard work are prime requisites for success in a profession which requires such a thorough knowledge of the arts and sciences as that of the expert draftsman. That encouragement for the draftsman is not lacking, however, is shown by the closing remarks of Mr. Lovekin's address:

"Shipbuilding at the present time is in a most prosperous condition, and it will not be long before all of the shipyards in the United States will be filled with orders. Further than this, it looks to me as though shipbuilding in this country will have full sway for years to come. In fact, I think it fair to state that we will ultimately rank as the greatest of all shipbuilding countries, for surely no other country possesses the natural advantages that we do in these United States."

Shipbuilding in Navy Yards

In the controversy over shipbuilding in navy yards the views of a naval officer given in this issue are of interest, as they throw some light upon the difficulties experienced in providing steady employment for a large force of skilled workmen in a navy yard. As a solution of this problem, he suggests that the navy yards take up the construction of vessels of a distinctly non-military type, as the work on such vessels could be carried on intermittently. In this way the yard force necessary for handling rush repair work would be kept intact, and during slack periods employment would be provided for the men. While such a plan might prove beneficial in maintaining the organization of the yard, yet it would hardly solve the problem of the excessive cost of ship construction in navy yards which has been the main point of the controversy. On account of military considerations, the question of shipbuilding in navy yards cannot be regarded in the same light as shipbuilding in private yards.

Southern Pacific Ferry Steamer Alameda

Latest Addition to Fleet of Passenger Ferry Steamers Operating Between San Francisco and East Bay Cities

BY EDW. W. OLIN*

It is not generally known that the Southern Pacific Railroad Company has a fleet of passenger ferry steamers operating between San Francisco and the East Bay cities, Oakland, Alameda and Berkeley, which in the point of equipment and service is probably not equaled anywhere in the United States. This fleet consists of ten passenger ferry steamers to which has lately been added the new side-wheel ferry steamer *Alameda* of the following dimensions:

Length over all	293 feet
Length between perpendiculars	273 feet
Beam molded	42 feet
Width over guards	76 feet
Depth molded	17 feet
Displacement, light	1,550 tons
Draft, light	8 feet 3 inches

Besides being the largest and fastest ferry steamer on San Francisco Bay, every effort was put forth to make her the safest, in line with the company's medal-winning policy of "Safety First." She was designed and built under the personal supervision of Mr. Wm. McKenzie, superintendent of ferry and river steamers of the Southern Pacific Company, at a cost exceeding $400,000 (£82,000).

This is the first of a program of three vessels of the same type, with the view of reducing the time between San Francisco and Oakland to 15 minutes, to accommodate the rapidly increasing ferry traffic over the distance of 3⅝ miles between these cities.

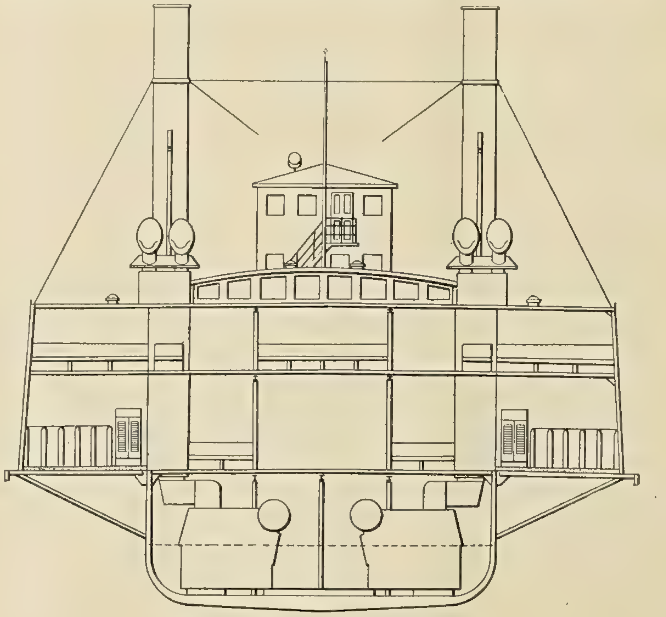
The Southern Pacific ferry service being a part of the great Electric Suburban System, must, in order to to maintain its already efficient service, have a ferry service that will meet each train with clocklike regularity.

Volume of Traffic

The importance of this statement becomes apparent when it is considered that these ferry steamers connect with 749 trains daily and transport about 59,000 passengers each day. During rush hours these steamers handle about 3,500 passengers per trip, and to facilitate the loading and unloading of this human cargo their design and construction must be such that the 3,500 passengers can disembark in less than three minutes.

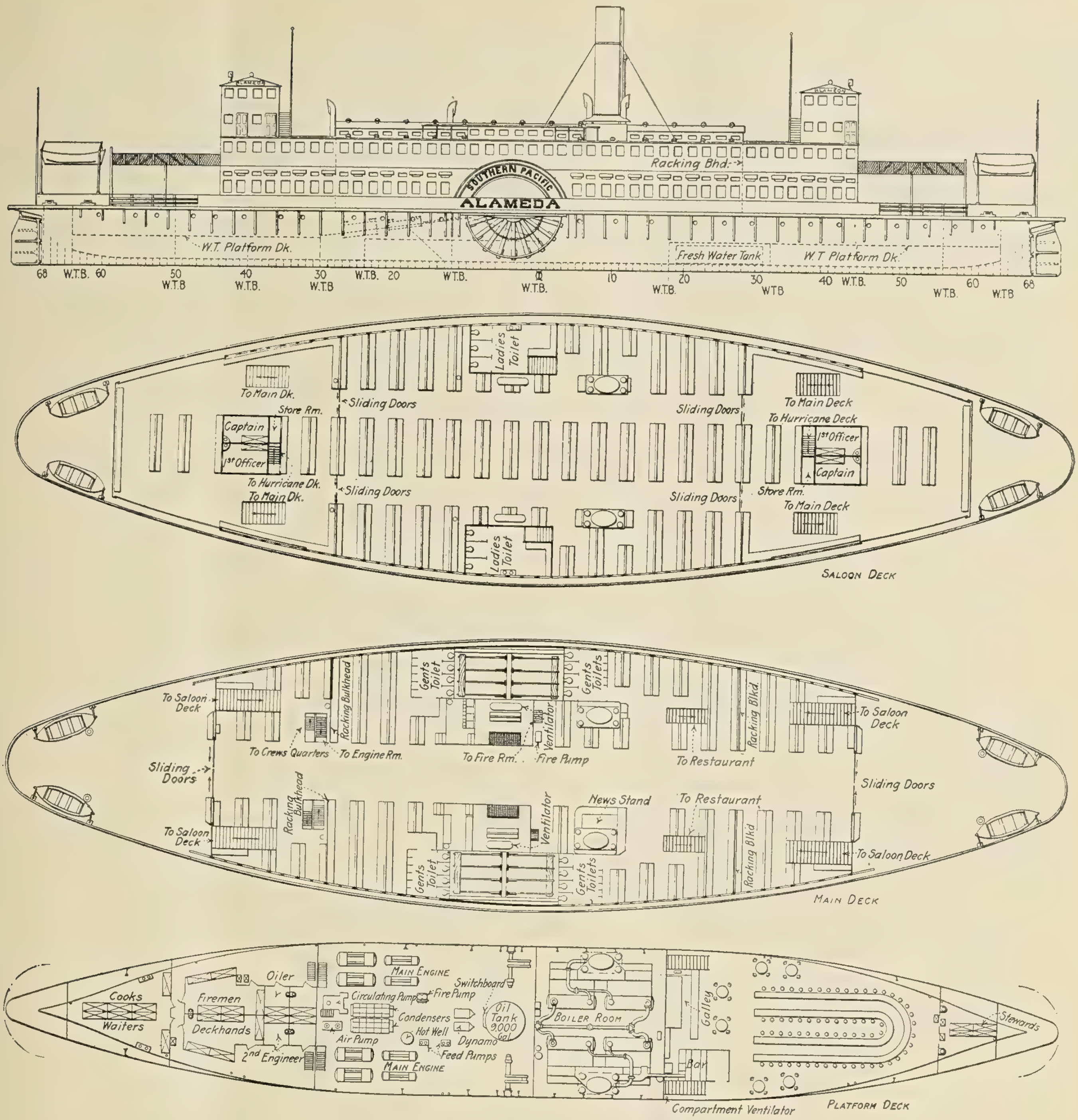
To meet this latter requirement a 16-foot gangway extends down the centerline of the boat the full lengh of the main deck, to allow free movement without excessive crowding of passengers. In the cabin on the saloon deck two 8-foot gangways extend throughout the cabin, while the saloon deck extends beyond the houseline about 30 feet and is provided with a 24-foot side landing on each side the same as on the main deck. In this manner passengers are unloaded from the main and saloon decks very rapidly.

Allowing 21 inches to a seat, the steamer *Alameda* will seat a total of 1,680 passengers, divided as follows: Main deck 628, saloon deck inside 636, saloon deck outside 316. To meet the public demand for more seats in the open air, seats were left outside the saloon-deck cabin which are



Section Through Boiler Room

* Foreman Draftsman, Southern Pacific Shipyard, West Oakland, Cal.



Profile and Deck Plans of the *Alameda*

sheltered only by the sides and the extension of the hurricane deck.

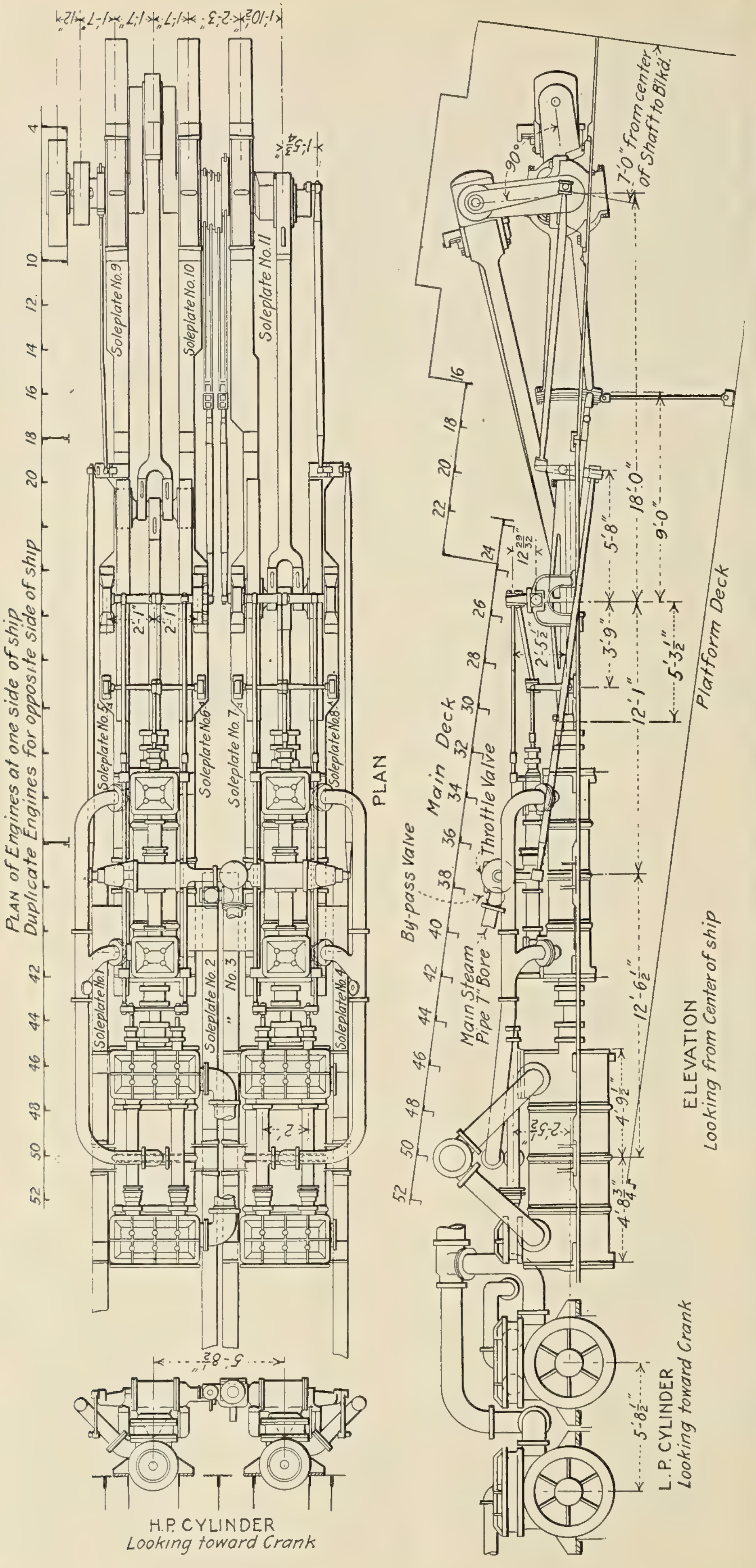
While the time the passengers remain on the boat is only about 20 minutes, great consideration has been given to their comfort. Toilets and lavatories for gentlemen are provided on each side of the paddle box on the main deck. There is also a news stand and a bootblack stand as well as sanitary drinking fountains. Over each paddle box on each side of the saloon deck is located the ladies' toilet, waiting room and lavatory with a matron in attendance. Sanitary drinking fountains are also provided on this deck.

Special attention has been given to the restaurant, which is quite an elaborate affair for this serviec, seating about 76 people. It occupies a space 75 feet forward of the boiler room on the platform deck and has double horseshoe counters as well as private tables. The restaurant presents a very neat and pleasing appearance. The galley is located in the after-end of the restaurant and is open for the inspection of the public, as it is not screened in any way. A No. 2 Audiffren Sinquine refrigerating machine is also installed. The bar room and buffet is located in the restaurant and occupies a space 9 feet by 12 feet, which is built in, forming a separate room.

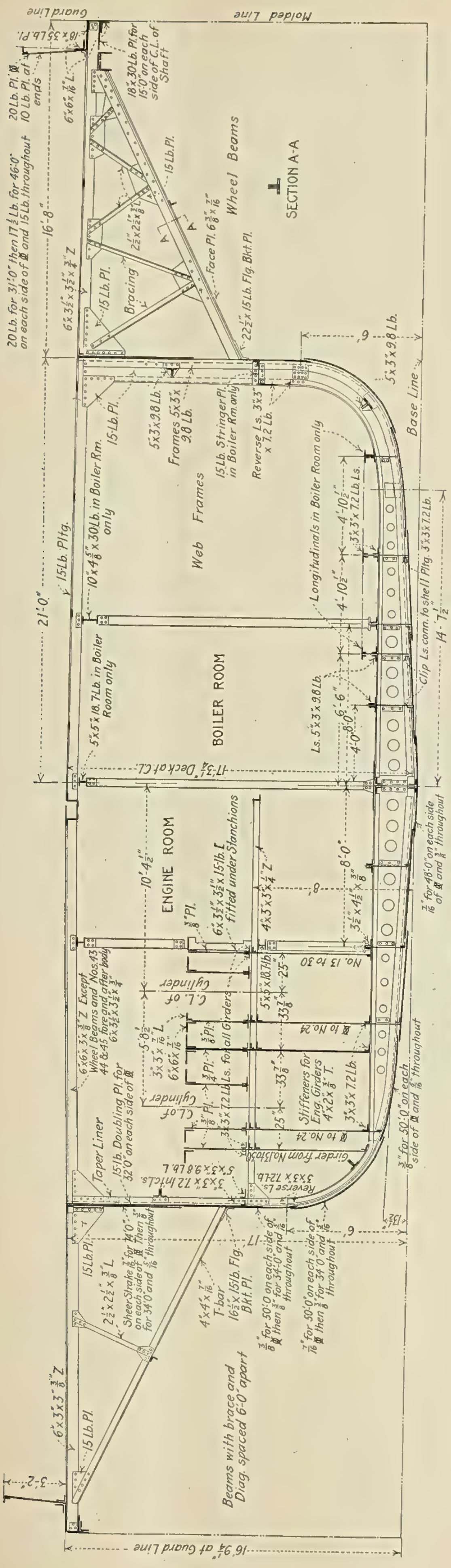
Hull Construction

The hull is a knockdown steel structure, built by the New York Shipbuilding Co., of Camden, N. J., and reerected and riveted up at the Southern Pacific Company's shipyard, West Oakland, Cal. In connection with this it may be of interest to know that no difficulty was encountered in the erection and assembling of this hull.

A watertight platform deck 8 feet above the base line extends throughout the length of the ship except in way



One of the Double Tandem Compound Inclined Condensing Engines Which Drive the Side Wheels of the *Alameda*; Diameter of Cylinders, 20 and 40 Inches; Stroke, 6 Feet; Normal Revolutions per Minute, 25; Indicated Horsepower, 2,500



Sections Through Engine Room and Boiler Room, Showing Scantlings

of the boiler room. Immediately abaft the boiler room 60 feet of this deck is taken up by the main engines, while the restaurant occupies the space forward of the boiler room, as before mentioned. The crew accommodations occupy the rest of this deck up to the collision bulkhead.

Twelve watertight transverse bulkheads, seven of which extend to the main deck and five to the platform deck, tend to make this steamer the safest on San Francisco Bay, as any two compartments may be flooded without sinking the boat. That this feature is of prime importance becomes apparent when it is considered that there are eight ferry routes radiating from the Union Depot, San Francisco Market street ferry, from which 18 ferries depart every hour, besides the regular merchant ships crossing the ferry routes. This makes the captain's berth anything but a pleasant one, especially during our heavy winter fogs.

The power plant consists of four Babcock & Wilcox marine boilers with a total heating surface of 10,400 square feet. The boilers are set two on each side of the centerline of the boat, the fireroom being fore and aft with a separate stack for each pair of boilers. Steam is generated at 200 pounds pressure by a steam-atomizing oil-burning system, using the Geo. E. Witt oil burner. Each boiler is equipped with one No. 12 monitor injector for auxiliary feed, the main feed being supplied by two 10-inch by 7-inch by 10-inch Knowles vertical duplex pumps, each with a capacity to supply all boilers. These boiler feed pumps are made automatic in their action by regulating the steam by a butterfly valve, which is controlled by a float in the hotwell.

PROPELLING MACHINERY

The main engines, which were built at the Southern Pacific Company's shops at Sacramento, Cal., consist of a double tandem compound inclined condensing engine on each side of the ship operating independent shafts with cranks set at 90 degrees. The engines are 20 inches by 40 inches diameter with a common stroke of 8 feet and will develop about 2,500 indicated horsepower at 25 revolutions per minute. Both the high- and low-pressure cylinders are equipped with open-box slide valves with Richardson balance strips. The high-pressure cylinder has in addition an auxiliary rotary cutoff located between the steam chests. Between the two cutoff valves is located the main throttle valve, which has a bypass connecting to the low-pressure cylinders for emergency use. The main valves are operated by the Stephenson link motion with stationary links.

It is usual with paddle-wheel steamers of this type to continue the shaft through from side to side, being connected to the inboard engine cranks by an intermediate shaft and drag cranks, but as mentioned before, each wheel is operated independently, which greatly facilitates the control of the ship, as by backing on one wheel and going ahead on the other the ship can be made to turn in her own length.

As the depth of water for about three-fourths mile out from Alameda and Oakland Moles is only 9 feet at low tide, it was impossible to consider a screw propeller of suitable proportions for a ferry steamer of the *Alameda's* dimensions. As the boat is double-ended and runs in one direction as much as the other, a radial paddle was decided upon as being the most suitable for the bay ferry service. The wheel shaft is 16 inches in diameter, of cast vanadium steel, and has four cast-steel wheel flanges or centers to each wheel shaft. Radiating from this wheel flange are 20 bucket arms of 3¾ inches by 12 inches Oregon pine. The buckets are also of Oregon pine 3¾ inches by 18 inches wide by 12 feet 3 inches long.

The wheel is 24 feet 6 inches diameter over buckets and has a 3-foot dip when light-loaded.

Each pilot house is equipped with two Hutchison rotation indicators which are connected to the port and starboard engine shafts to indicate the direction the wheels are rotating and which act as a means for checking bells between the pilot house and engine room.

Auxiliaries

A very complete equipment of auxiliary machinery is installed, part of which has already been mentioned. The condensing equipment consists of two Worthington surface condensers of 2,400 square feet of cooling surface each, with valves in the exhaust and circulating pipes for running each condenser independent should occasion demand it. The following pumps are supplied:

One 12-inch Blake volute circulating pump driven by a vertical 8-inch by 7-inch Blake open frame engine.

One 12-inch by 28-inch by 18-inch Knowles single-acting twin beam air pump.

Two 10-inch by 7-inch by 10-inch Knowles vertical duplex boiler feed pumps.

Two bilge and fire pumps 12-inch by 8½-inch by 10-inch Knowles vertical duplex pumps.

One of the latter is located in the engine room and one on the main deck. They are connected to the bilges and separate sea cocks and are connected together with suitable suction and distributing manifolds. As the deck fire pump is constantly running to maintain the necessary fire-line pressure a connection is taken from this line for the water closets and other sanitary systems.

One fresh-water pump 5¼ inches by 3½ inches by 5 inches, of the Knowles vertical type, supplies fresh water to the restaurant and drinking fountains, and two oil pumps 4½ by 2¾ inches by 4 inches, of the Knowles vertical duplex type, are supplied, each of which is able to supply the oil at the necessary pressure.

The electric plant consists of two 35 kilowatt General Electric turbine generators, each of which is capable of illuminating the entire ship. Under each pilot house is located a 4-inch by 6-inch C. H. Evans steering engine.

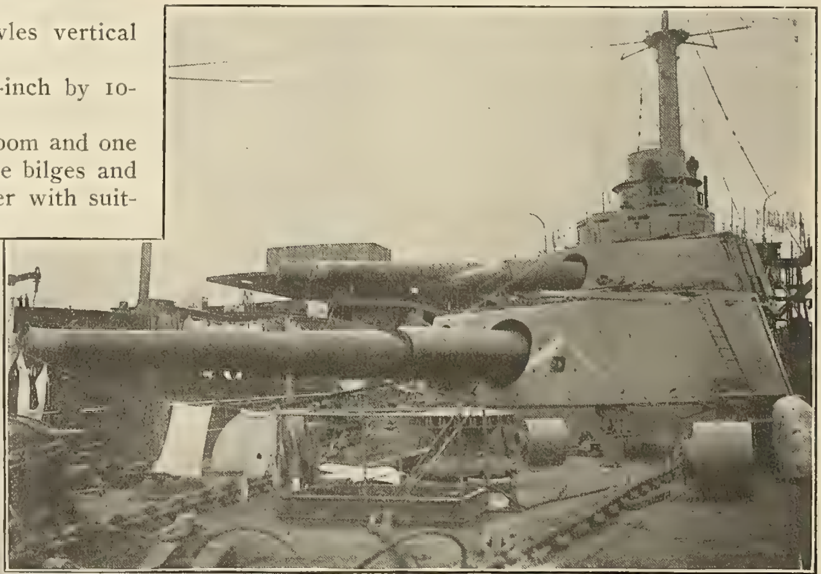
Considering the nature of the service for which the *Alameda* is intended, her design and equipment leave little to be desired. The facilities for the rapid handling of a large number of passengers at the terminals and for their safety and comfort while in transit, should prove a valuable asset to the owners.

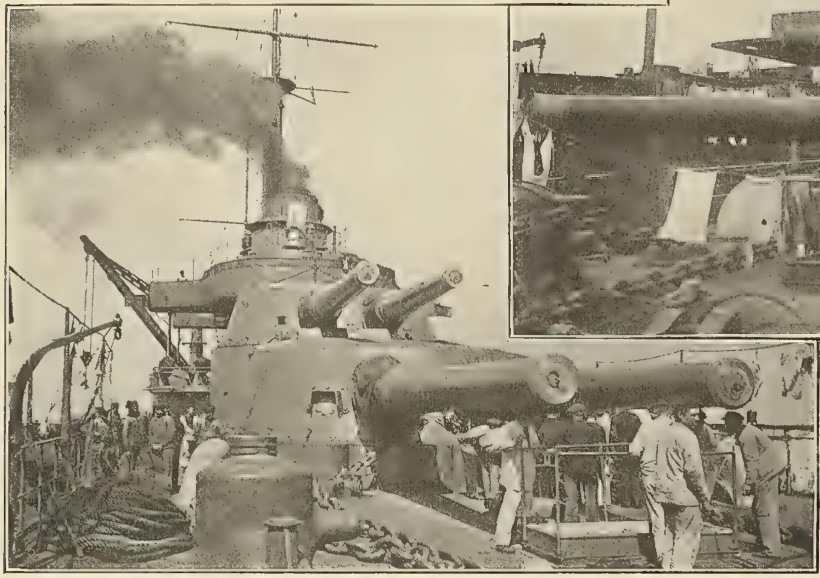
French Battleships Bretagne and Provence

The battleships *Bretagne* and *Provence,* laid down on May 1, 1912, and July 22, 1912, respectively, have recently carried out their official trials and now form a part of the Mediterranean fleet of the French navy, where they are the largest battleships in the fleet. The main particulars of these two battleships are:

Length overall	545 feet
Beam	88 feet
Draft, forward	28 feet
Draft, aft	29 feet 3 inches
Displacement, on normal draft	23,546 tons
Area of midship section	2,752 square feet
Brake horsepower	28,000
Contract speed	20 knots

In both vessels the hull is similar to that of the *France,* there being, however, no special under-water protection, as was the case in the vessels of the *Gascogne* class, described in the December, 1914, issue of this journal. The main armor belt extends for the full length of the ship, having a maximum thickness of 11 inches for a length of 197 feet amidships, reduced to 7 inches at the ends. This belt of armor extends 5 feet 7 inches above the load waterline and 7 feet 9 inches below the load waterline. Amidships, the funnels, the secondary battery, the base of the conning tower and the base of the central turret are protected by 7-inch armor, forming a citadel. All casemates are also protected by 7-inch armor. There are two protective decks, one of 1 9/16-inch plate, and the other of 3-inch plate, the lower protective deck extending 6 feet below the load waterline.





Views of Forward Turrets of French Battleship *Bretagne*

The single conning tower, which extends well above the forward turrets, is protected by 12-inch armor, the tube leading to the lower decks being protected by 10-inch armor. The conning tower is divided into two compartments. The forward compartment is the navigating

station and the after compartment the fire-control station. Above the conning tower are two range-finder stations.

On the *Bretagne* steam is supplied at a pressure of 256 pounds per square inch by twenty-four Niclausse boilers of an improved type, having a total heating surface of 65,000 square feet and a total grate area of 2,090 square feet. The funnels on this ship extend to a height of 66 feet above the load waterline. On the *Provence* steam is supplied at the same pressure by eighteen boilers of the Guyot du Temple type, having a total heating surface of 63,000 square feet and a total grate area of 1,500 square feet. This is the first time that boilers of the torpedo boat type have been used on a ship of this size, and the performance of the *Provence* under severe service conditions will be followed with interest—especially so because some of the vessels of the *Normandie* class will also be fitted with this type of boilers.

According to the contract, the following figures for coal consumption were stipulated: 10-hour full power trial, 2,700 pounds per mile; 3-hour full power trial, forced draft, 321 pounds per square foot grate area; air-pressure in boiler rooms, 1 inch of water; 24-hour trial, 1,853 pounds per mile; endurance trial with one-half boilers in service, 1,168 pounds per mile. The bunkers have a capacity of 2,700 tons of coal and 300 tons of oil.

In both vessels the main engines are Parsons turbines, arranged, according to the latest practice, on four shafts, without cruising turbines. The engines for the *Bretagne* were supplied by the Mediterranean Works and for the *Provence* by the Loire Works.

The electric plant consists of four generators, each of 200 kilowatts capacity. Forward and aft, near the turrets, there are also two other similar electric generators, making the total power of the generating sets 1,700 horsepower. All of the generators are driven by high-speed reciprocating engines.

Nearly all of the auxiliaries on the vessels are operated by electricity. Except in the engine and condensing rooms, all parts of the ship are ventilated by electrically-driven fans. The ammunition rooms are cooled by Westinghouse-Leblanc refrigerating apparatus.

The *Bretagne* and *Provence* are the first battleships of the French navy to carry an armament consisting of ten 13.5-inch guns all mounted on the centerline of the vessel. The guns are placed in five turrets located on the centerline of the ship, the guns in turret No. 1, forward, being at an elevation of 30 feet 6 inches above the load waterline; those in turret No. 2 at an elevation of 37 feet 9 inches; those in No. 3, 36 feet 6 inches; in No. 4, 29 feet, and in No. 5, 22 feet. The arc of fire for the guns in turrets Nos. 1 and 2 is 135 degrees; in Nos. 2 and 4, 140 degrees, and No. 3, 120 degrees. The turrets are protected by 13.5-inch armor on the face; 10-inch armor at the rear, while the base is protected by 11-inch armor.

The secondary armament consists of twenty-two 5.5-inch guns arranged in five casemates on each side of the ship. These guns have an arc of fire of 120 degrees and are located 19 feet above the load waterline Four 18-inch torpedo tubes are also provided.

Lloyd's Shipbuilding Returns.—Lloyd's Shipbuilding returns, which only take into account vessels of 100 tons and upwards the construction of which has actually begun, show that, excluding warships, there were 471 vessels of 1,587,467 gross tons under construction in the United Kingdom at the close of the quarter ending March 31. The tonnage now under construction in the United Kingdom is about 40,000 tons less than that which was in hand at the end of the last quarter and about 303,000 tons less than the total building twelve months ago.

Launch of the Gulfcoast

The oil-tank steamer *Gulfcoast*, contracted for in September, 1914, by the Gulf Refining Company, of Pittsburgh, Pa., was launched at the yards of the New York Shipbuilding Company, Camden, N. J., on March 27. This is the fourth oil-tank steamer to be built for the Gulf Refining Company by the Camden shipbuilders. Her principal dimensions are: 406 feet 6 inches length overall; 51 feet beam and 30 feet 3 inches depth. The vessel is of the two-deck type with raised poop and quarter deck, while the expansion trunk is carried above the main deck. The capacity of the vessel is 2,285,000 gallons of oil in bulk carried in twenty-two separate oiltight compartments, in addition to which there is also a large cargo hold and smaller compartments fitted with the necessary cargo

Launch of the *Gulfcoast*

booms, winches and handling gear in which barreled oil or general cargo can be transported.

The propelling machinery, located aft, designed to give the vessel an average service speed of 11½ knots, consists of triple-expansion engines with cylinders 27, 45 and 75 inches diameter by 48 inches stroke, developing 2,700 indicated horsepower. Steam is supplied at 190 pounds pressure by three single-ended Scotch boilers, 14 feet 8 inches diameter and 11 feet long. The boilers are fitted to burn either coal or oil, the oil burners being of the mechanical atomizing type. The bunkers for the oil fuel have a capacity of 176,000 gallons and are placed at both ends of the vessel, so that either cargo or fuel may be carried as desired.

In addition to the usual auxiliaries, the *Gulfcoast* is fitted with a 2-ton ice machine, an up-to-date machine shop in the engine room, steam- and hand-steering gear and a powerful automatic towing machine. In all, there are seven cargo pumps, each capable of discharging cargo at the same time through an independent line. The electric plant consists of two 10-kilowatt General Electric marine direct-connected sets for 110 volts driven by vertical engines located at the main deck in the engine space.

The ship's officers and wireless operator are berthed amidships, the other quarters being under the raised quarter deck in the after part of the vessel.

Speed Control on Dreadnought Pennsylvania

Description of Instruments Installed for Recording Revolutions of Propeller Shafts—Data Recorded Used to Control Speed of Ship

To promote harmony between the engine room and the bridge, and make it possible to get just that speed from the engines which is necessary for definite purposes, a system of instruments is to be used on the *Pennsylvania* which gives direct and immediate information at all times on the important subject of speeds of the several shafts, together with the corresponding speed of the ship and other similar matters. The essential parts of this installation, as fitted in the two engine rooms, are shown

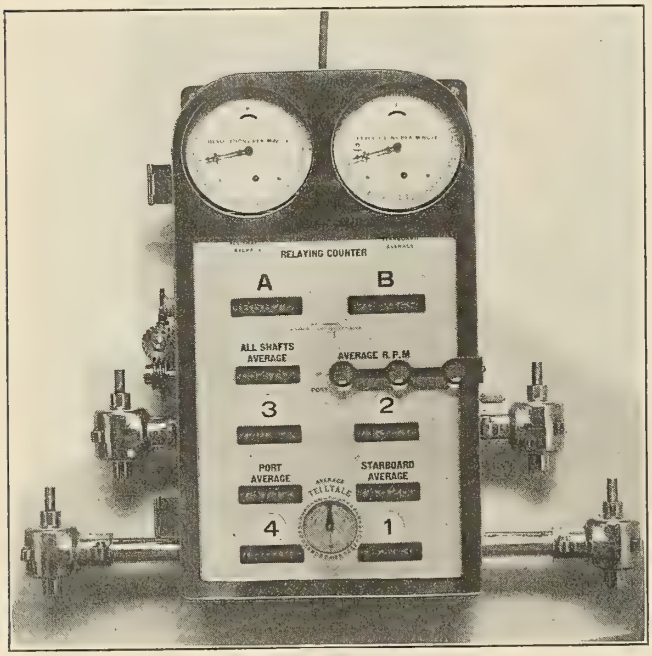


Fig. 1

in Figs. 1 and 2, while Fig. 3 shows the interior of the instrument indicated in Fig. 1. The instruments on the bridge and in the chart house repeat automatically this same information. The apparatus was designed and built by the Cummings Ship Instrument Works, Boston, Mass.

While the instrument shown in Figs. 1 and 3 is complicated in appearance, it is really simply a combination of what in previous ships has been several independent instruments. The nine revolution counters have been in many cases fitted in three or more separate instruments, while the two stop clocks at the top have usually also been separate from the revolution counter equipment, and the telltale is also frequently separate. The instrument as a whole, however, has many interesting features.

The four shafts of the *Pennsylvan*ia are operated from two engine rooms, two shafts in each. The counters from shafts 1 and 2 in the starboard engine room are run by the gears shown at the right of the instrument, and corresponding with the figures given under those shaft numbers. Similarly, shafts 3 and 4 in the port engine room are arranged on the left of the instrument. The revolutions of the shafts are transmitted to the instrument through the "one-way" gears at right and left respectively, these being arranged so that the counters always *add up,* regardless of the direction of rotation of the engine. The counters, therefore, always tell the total number of revolutions made, whether those were ahead or astern, and thus indicate the amount of work done by the engine.

By a combination of gears the indications of shafts 1 and 2 are averaged in the counter shown between those of the two shafts. It will be noted by a comparison with the figures that the number of revolutions indicated in that average is, in fact, a true average between the figure for No. 1 and that for No. 2. The use of positive-drive gearing for this purpose, as shown in Fig. 3, avoids, it is claimed, the errors inseparable from other methods of driving counters. In a similar way the average of the port shafts is given, and then by a combination of these two averages the average is obtained at once for all shafts, as shown just above No. 3 at the left of the instrument in Fig. 1.

The counters *A* and *B* are used for trial trip purposes and for recording the distance run on any given course. This is important when running on dead reckoning or navigating through a fog, or when for other reasons it becomes necessary to know just how far the ship has been running. It will be noted that the sum of the figures under *A* and *B* is just equal to the total average of all shafts. When *A* is running *B* is stationary, and vice versa. These are controlled from the bridge by an electric circuit so adjusted that only one can run at a time, and it is claimed that the operation is so instantaneously handled that the records are thoroughly reliable in every way.

The telltale at the bottom, showing which engine is running the faster, is controlled by the starboard average counter and port average counter. When the average

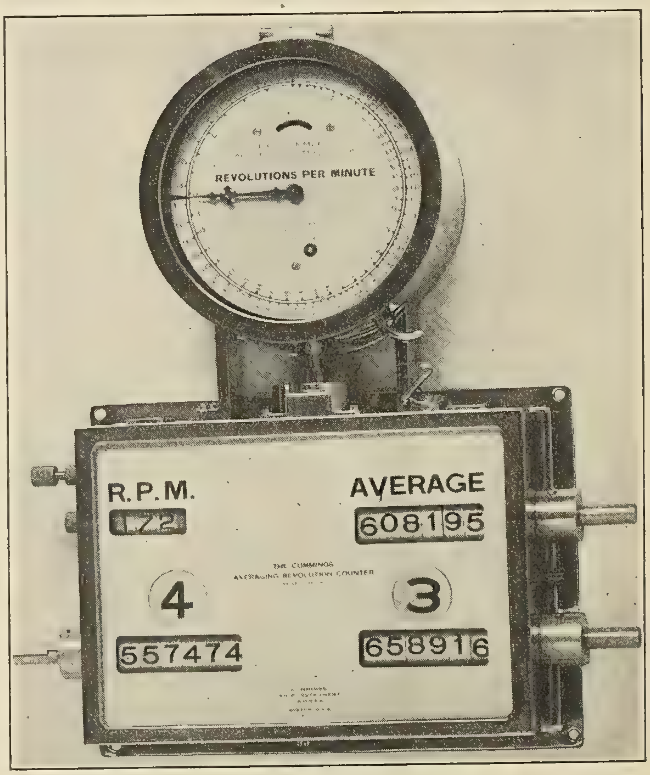


Fig. 2

revolutions per minute of the starboard engines is the same as that of the port engines the hand does not move. If one side gains, the hand revolves, indicating by its direction of rotation which side is running faster. The dial around the telltale is graduated in revolutions.

The automatic stop clock in the upper right corner is operated mechanically from the starboard average counter. The mechanism is similar to that on the ordinary

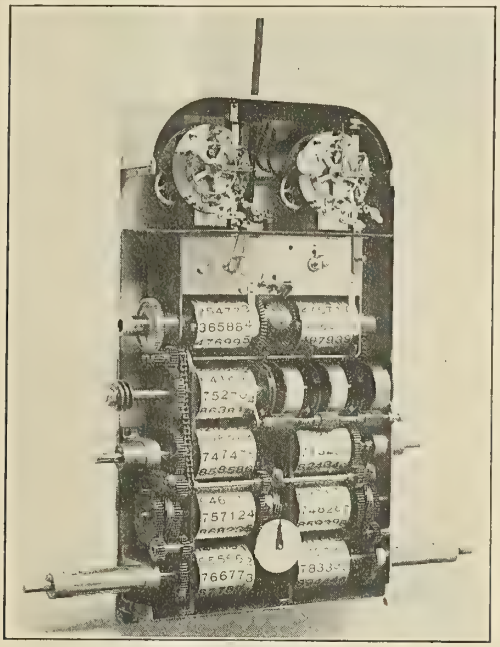


Fig. 3

stop watch, but for continuous use on shipboard a special clock had to be devised which is very much more rugged than any stop watch.

The hand of the clock, started from zero automatically, stops after 100 revolutions of the shaft have been made. It remains stationary, pointing to the revolutions per minute for a period of 75 revolutions, and is then automatically released and returned to zero. This operation is repeated every 200 revolutions.

As the revolutions governing this clock are taken off from the starboard average revolution counter, this indicates the average number of revolutions per minute for shafts 1 and 2. As installed on shipboard, the speed of ship corresponding to revolutions per minute is placed on the outer edge of the dial, and the engineer at once knows just how fast the vessel is moving through the water. If the engines are running faster than 200 revolutions per minute a reading is given oftener than once a minute. The clocks may be thrown out of gear when not in use.

The operation of the instrument shown in Fig. 2, which is located in the port engine room, is identical with that already described. It shows just what the port engines are doing, in the same way that the starboard instrument shows what the starboard engines are doing. The starboard instrument has the further advantage, however, of showing what *all* the shafts are doing, and of carrying the relaying counter for trial trip and other purposes, as well as the telltale and other details.

The indication of average revolutions per minute by a source independent of the stop clock is sometimes found important. This is given at the upper left corner of the rectangular case in Fig. 2, the knurled knob at the left of the case being pressed in to connect up the gears. The same indications are given on the right side of the large instrument shown in Fig. 1, not only for the starboard average shafts, but for the port average and all shafts. As the cylinders from which these readings are taken are made very compact, and consequently with small figures, magnifying lenses have been introduced to make readings easy.

It should be understood that on the bridge and in other navigating stations similar stop clocks are placed, operated by vacuum and controlled by the geared valve shown at the middle of the left side, Fig. 1. Engine logs are also fitted on the bridge for showing the distance covered by the ship. The system has been worked out in such detail that it is quite unnecessary for the navigating officer to telehpone to the engine room, or communicate in any other way, to learn what the engines are doing. The information is all before him in the automatic instruments; he can see at a glance just what the conditions are, and can take what steps may be necessary to produce the result he desires.

Equipment similar to the *Pennsylvania's* has been fitted on practically every dreadnought in the United States navy, and on many of the earlier ships. It happens, however, that in the other cases the system has not been carried out to quite the same degree of thoroughness, although the major items of the information are transmitted automatically to the bridge in all cases.

Latest Developments in Marine Electrical Engineering*

BY H. A. HORNOR †

Although it is to be expected that electrical marine applications should be rapid, the developments in this branch of engineering in the last five years are remarkable. Minor applications which were in the experimental stage three years ago are now regular requirements for the more severe and larger service. Such equipments as electric bilge pumps, electric steering gear, etc., though they were utilized on certain foreign ships-of-the-line years ago, held no place in our practice until recently. It is a long span from Jacobi's electrically propelled boat of 1838 to the U. S. fleet collier *Jupiter* of 1913, but the gap of years contains progress in the art that will stabilize the application.

General Installation

Following the usage of the time, 80 volts direct current was first adopted. The battleships *Kearsarge* and *Kentucky,* building in 1899, were equipped with a three-wire system using 80 and 160 volts. This precedent led to the standard voltage of 125 volts adopted in 1902. Last year the voltage was raised to 230 volts direct current.

This increase of potential, caused by the expansion of power applications, is disadvantageous to the lighting system and searchlights. The development of the 230-volt tungsten lamp in this country is not such as to insure its adoption at the present time, and searchlight lamps require an arc voltage of 50 to 55. These conditions have brought about the consideration of a system employing either three-wire generators or two-wire generators and balancers. Thus there is provided 230 volts for the power system and 120 volts for lighting and searchlights. A standard three-wire generator has not been adopted, and the proposition, therefore, must be classified experimental.

Early in 1913 the standard conduit installation which had for some years been undergoing modifications and

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experimentations gave place to lead-covered steel-armored conductors. This required new designs and methods for its proper installation, entailing changes in all the appliances, fittings and fixtures throughout the equipment. It has led to a great reduction in grounds, it reduces the space and weight required for installation, it allows for further expansion, and incidentally presents a less obtrusive appearance.

Much improvement has been sought in the use of special insulating compositions to supersede porcelain. Various types of asbestos lumber, ebony asbestos wood, and like patented preparations are now generally required. Control panels, interior fittings, etc., are constructed of such materials and at the present time seem to give satisfaction. These experiments have led to the requirement of some such material for the main switchboards, superseding slate for this purpose. As this is a recent requirement, no switchboards of large size have been manufactured and the questions involved rest in the hands of the designer.

As the tungsten lamp has improved in land practice, it now becomes acceptable in marine work. As stated above, the voltage (120) is still maintained the same because of the tungsten lamp. Vibrations in certain parts of the vessel, naturally in the vicinity of the engine spaces, is severe, and carbon lamps cannot be entirely eliminated. The introduction of the tungsten lamps has awakened a renewed interest in the principles of good illumination, and experiments are now under way with prismatic globes, special reflectors, etc.

Many of the above points, and perhaps all combined, have brought improved methods of light distribution, and the manner of controlling light. This in turn has caused more economical methods of running feeders to centers of distribution, and so produced an installation that is far superior to the old methods in cost of upkeep and reliability of service. Incidentally, it has tended to simplicity which materially affects the cost both first and last and points to a hoped-for standard.

Searchlights

The old automatic magnet control of the arc has now been replaced by the motor-operated lamp. Experiments with different compositions of carbon so as to produce greater intrinsic brightness at the source is in progress at the present time. The foreign manufacturer is employing an impregnated carbon which permits a higher potential at the arc—70 to 75 volts instead of 50 to 55 volts. A lamp using the alcohol spray is under consideration. This lamp is of interest, due to the increased illumination. A small positive carbon is used and high temperature of the arc is effected by the use of the alcohol spray. It is understood that impregnated carbons are also employed. It is not known whether any attempts have been made to utilize high power gas-filled tungsten lamps for this purpose, but it is supposed that such a field would be promising. The pendulum swings between the advantages of electrically controlled searchlights and hand or mechanically controlled lights, but at this time the electrically controlled light is not in favor.

Power System

The steady improvement and continued use of contactors for the control of motors has increased the use of automatic control for a varied number of applications. Dynamic braking, which quickly brings the motor armature to rest, is asserting its certain importance in many equipments.

Electricity is now solely depended upon for weighing the anchor, and, although the results of this application for all conditions of service are not known, it is reasonable to believe that the application will warrant its continuance.

Experimental work for the last five or six years has brought electrical steering gear into what appears to be a permanent requirement. The older systems tried did not give satisfactory results and it was not until the development of the contactor that experimental work was again resumed. There are now two systems designed which will be shortly tried in service. One is based on the use of two motors controlled by contactors; the other based on one motor controlled by a motor generator on the Ward-Leonard system. Any type of electrical system is to-day paralleled by the old steam system, but the indications are that the electric gear will supplant the steam.

The introduction of oil fuel instead of coal has changed the electric forced draft fan to a steam turbine driven fan, due in part to the fact that high-pressure and low volume of air is required, and also to the fact that the exhaust from these fans aids the heating of the boiler feed water.

The main drainage pumps are electrically driven, but the application to other main engine auxiliaries has not increased generally. There is a movement toward rotary steam pumps instead of the old reciprocating pumps which doubtless will lead in the end to the electric motor.

Interior Communication

The old types of incandescent lamp instruments have almost entirely disappeared and their place taken by the direct current motor-operated instrument. The communicating systems as a whole have increased greatly in extent. No absolute measure of this expansion can be given, but it is about 60 percent.

One of the most important and interesting developments is that of the gyroscopic compass. Since 1852, when Foucault in his laboratory studied the physical action of the gyroscope and laid down its laws, scientists and inventors endeavored to produce for it some commercial usefulness. It is not the purpose of this paper to describe or narrate the history of this application. Those who are interested will do well to read Mr. H. C. Ford's paper, entitled "The Electrically Driven Gyroscope in Marine Work," read before the American Institute of Electrical Engineers at Detroit, June 23, 1914. It answers the intention of these notes to record that recent improvements in the essential point of quickly damping the oscillations has advanced the practical adaptability of this instrument. A demonstration of this improvement was given by Mr. Elmer A. Sperry before the three-hundredth meeting of the American Institute of Electrical Engineers, held in Philadelphia last October.

Wireless Telegraph

The improvements in wireless telegraph apparatus have been rapid and important. Most of these advances have been recorded elsewhere and need no further comment. In general the lines of improvement tend to the use of a continuous wave in preference to the undamped wave. Much success has been achieved by the quench-spark system. Matters of practical installation are more carefully looked after, and the value of wireless as a safety factor has not been exaggerated by the press.

Submarine Signaling

Perhaps the most important advance in the protection of vessels occurred in the early part of this year. For many years and by many minds the transmission of sound signals through water was given special consider-

ation. Water as a medium of signaling has many more desirable characteristics than air. The submarine bell attached to the buoy, the lightship or the shore could emit signals such that a vessel equipped with water tank and receiver telephones could evade those places in which there was danger, and so be protected in foggy or thick weather. But there remained no under water means by which a vessel could itself communicate either with the shore or with another vessel. The submarine telegraph oscillator is the work of Prof. R. A. Fessenden, and provides for under water inter-communication by the telegraph or telephone.

So much interest surrounds this apparatus that it seems desirable to quote from an abstract of Mr. R. F. Blake's paper, read before the American Institute of Electrical Engineers at Philadelphia, October 12, 1914: "The apparatus consists of an oscillating electric motor generator which has a strong electro-magnet surrounding a central core on which is an alternating current winding. This copper tube is attached to a large diaphragm. When the alternating current passes through the core winding it induces a current in the copper tube, which, being free to move, vibrates back and forth, thus setting the diaphragm in vibration. . . . This oscillator can also be used as a receiver." From this brief description it can be seen that a most important field is now covered by this apparatus.

Electric Propulsion

Since Davenport, the Vermont blacksmith, exhibited his electric motor in London many attempts have been made to apply electricity to the propulsion of vessels. Many will recall the electric launches at the Chicago World's Fair in 1893. Abroad some light draft river craft were built and so squipped. A few years ago two electrically driven fire boats for the city of Chicago were successfully operated. A vessel built in England to ply in the Welland Canal was equipped with electric motors and Diesel oil engine generators. However, the first practical application to a sea-going vessel is the U. S. fleet collier *Jupiter*.

The keel of the *Jupiter* was laid at the Navy Yard, Mare Island, California, on October 18, 1911. The *Jupiter* was placed in commission April 7, 1913. The vessel was designed for a speed of 14 knots, developing 5,500 shaft horsepower with a load displacement of 19,300 tons at a draft of 27 feet 8½ inches. Her performance showed a speed of 14.99 knots, developing 7,151.9 shaft horsepower with a displacement of 19,452 tons at a draft of 27 feet 7½ inches. She has been in service over a year and a half, during which time she has had two trial trips, performed the regular functions of a collier, steamed 14,000 miles, and successfully arrived at the Philadelphia Navy Yard on a continuous trip from San Francisco, stopping only in the Panama Canal in order to view the operation of this great engineering project. During this service only two repairs have been made to the propelling apparatus. One of these could have happened to any type of engine; the other was of such minor importance that it need not be mentioned.

The success of the *Jupiter* is manyfold. The fuel economy is shown to be 25 percent better than the best of like vessels equipped with other methods of propulsion. The propellers are exceedingly efficient, giving the same speed as sister ships with a reduction of 300 to 800 horsepower. The maneuvering qualities of the vessel are markedly superior, due to the rapidity of reversal and also to the fact that full power is available for backing. The ship is about 542 feet long and about 65 feet in beam, and would be extremely unwieldy if it were not possible to aid the rudder by means of the propelling motors. There are many more advantages, but the all-important matter is well summed up in the conclusion of a paper by Lieut. S. M. Robinson, U. S. N., read before the Society of Naval Architects and Marine Engineers, on December 10, 1914: "After all, the greatest test of the satisfactory working of any machinery is whether or not the men who are actually handling and caring for it are pleased with it. If this test applies to the *Jupiter's* machinery it certainly is an unqualified success. In particular is this true if the matter is referred to the coal passers in the fire room, who have to handle much less coal than do the men on sister ships. The ship can make her contract speed of 14 knots without using forced draft at all."

The success of the *Jupiter* has led the U. S. Government to extend this application, and electric propulsion is now authorized for the battleship *California*, now building in the New York Navy Yard. This equipment naturally will be an advancement over that of the *Jupiter*. With this development many more advantages may be expected, as electricity provides ready means for the accurate measurement and determination of propulsion factors. As the application grows many problems of the naval architect and marine engineer will be reopened, doubtless to the betterment of water transportation. There remains to the shipbuilding art to-day many questions that are settled upon theory because facilities are not given to practically record the conditions of performance. This obstruction will be greatly removed by the application of electricity.

The first announcement of the principles of electric propulsion of naval vessels may be found in a paper read by Mr. W. L. R. Emmet before the Society of Naval Architects and Marine Engineers on November 18, 1909. It is to Mr. Emmet that credit should be given for the introduction of what will doubtless prove to be the best and safest means of ship propulsion, to say nothing of the increased possibilities for the advancement of the art of ship design.

Conclusion

The last half decade is replete with progress in the marine applications of electricity. It is noteworthy that these applications have followed land development in the electric field. From an auxiliary of little importance except lighting, electrical applications of power have grown until now we find electricity entering into the main design of the vessel. The marine engineer is willing to admit that an electric motor will drive a ship, but imagine his astonishment when he finds in the future to what extent the full effect of this application will lead!

Monthly Shipbuilding Returns.—The Bureau of Navigation, Department of Commerce, reports 111 sailing, steam and unrigged vessels of 24,538 gross tons built in the United States and officially numbered during the month of March. Seven of these vessels, aggregating 18,567 gross tons, were steel steamships. From other sources than construction, six vessels (officially numbered in accordance with the Act of August 18, 1914) of 15,123 gross tons, were also added to the American merchant marine during the month. The Bureau of Navigation further reports for the nine months ended March 31, 714 vessels of 153,326 gross tons built and officially numbered in the United States. During the corresponding period a year ago, 881 vessels of 215,059 gross tons were built and officially numbered.

Sale of the Skinner Shipbuilding Company.—The property of the Skinner Shipbuilding & Dry Dock Company, Baltimore, Md., has been purchased recently at public auction by a committee representing the bondholders of the company.

Application of Electricity to Propulsion*

Fifty-Foot Motor Boat Equipped with Electric Drive for Experimental Purposes—Problems to Be Solved

BY WILLIAM T. DONNELLY †

Since the advent of electricity and its marvelous development for lighting and power through its distribution from central stations, engineers have repeatedly turned their attention to the possibility of its use for marine purposes. It was early found practical to install an independently driven electric lighting plant on board a steamship, and from time to time additional work has been found for the auxiliary use of electricity on board vessels. Repeated examination, however, has resulted in a many times repeated statement that nothing was to be gained by turning mechanical energy into electricity, and then back into mechanical energy for application to ship propulsion. This conclusion was more or less confirmed from time to time by the building of individual vessels propelled by electricity, and this was the situation when the writer's attention was first concentrated upon the problem as to whether it was possible that engineers generally were overlooking a broad method of the application of electricity to marine transportation.

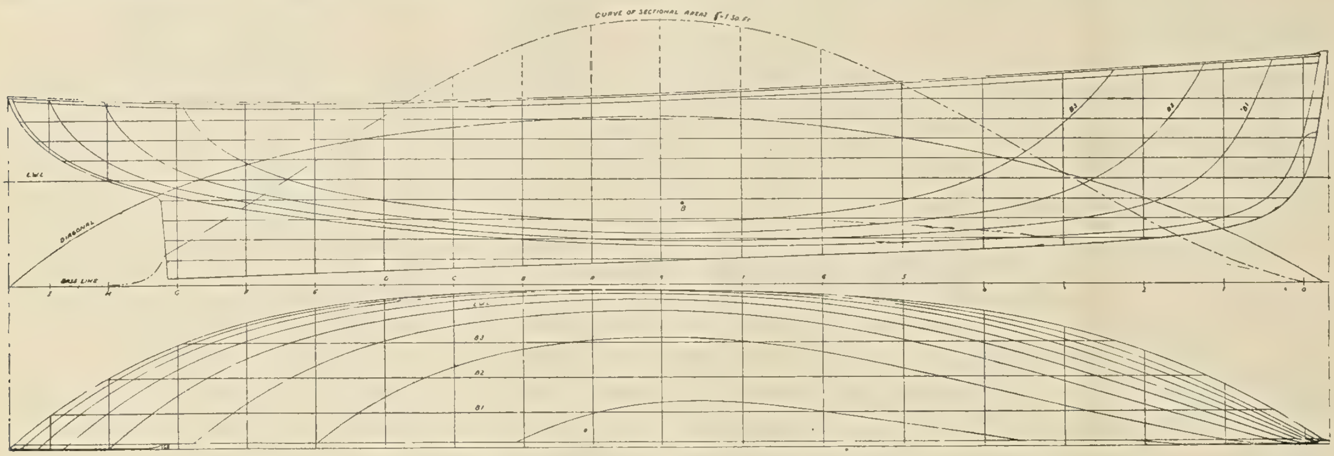


Fig. 1.—Sheer Plan and Waterlines of the *Dawn*

In this case at least a problem was definitely and clearly set before the writer's mind, without any possible solution in sight, and a considerable time was spent in looking at an apparently blank wall. Finally the comparison was made between the movement of cars by means of a multiple electric drive and the towing of vessels by a tug boat, when it first dawned upon the writer that towing was a means of transmitting power, which upon analysis was of the most crude form—that is, a tow boat in towing a vessel transmits power to that vessel, but is limited in character to a force applied in one direction only, and only in a straight line. The rate of transmitting power is, of course, very simple, and is represented by the pull on the tow line expressed in pounds multiplied by the speed of advance in feet per minute of the tow boat and following vessel. To express the transmission in horsepower it is only necessary to divide the product by 33,000 pounds, representing one horsepower.

When so much of the problem had been solved, the rest was very simple. It was very apparent that the use of electricity for power purposes on land was simply the displacing of older and cruder means of power transmission represented by the turning shaft, the running belt or wire rope. Each of these devices was, however, much more developed and less crude in form than that of towing with a tow line.

The invention I am calling attention to is simply due to the full comprehension of the fundamental principles of the application of power to marine propulsion, and then adapting to that purpose electricity by means of apparatus already fully developed. Stated in its simplest form, it is the generation of electricity upon one vessel transmitting it by means of a flexible waterproof cable to one or more other vessels, and there utilizing the energy for propulsion through propelling apparatus operated by the electric motor.

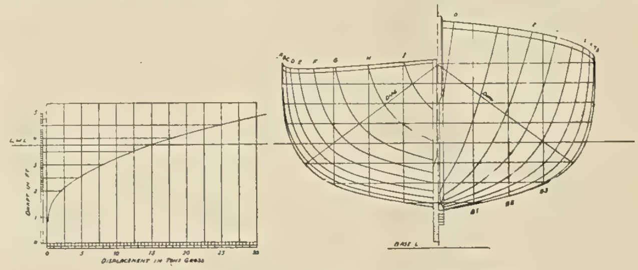


Fig. 2.—Displacement Curve and Body Plan

The writer is fully aware that the possibility, desirability and practicability of doing this may be questioned, and one of the objects of this paper is to put these questions clearly and distinctly before engineers, and at the same time to describe a vessel designed and constructed with the object of testing and determining in an engineering and scientific manner the important questions involved in the problem.

Electrically Propelled Yacht Dawn

The lines of the *Dawn*, Fig. 1, were drawn by Charles D. Mower in 1909; the controlling features in the design were that the boat should be of moderate speed, not more than nine knots, and be of such proportions as to make the functions of hull resistance comparable to commercial vessels. In other words, fineness of lines and refinement of hull were to be a secondary consideration. Consequently the *Dawn* was given a beam of 12 feet on an overall length of 50 feet, with approximately 46 feet length

* Extract from paper read before the Brooklyn Engineers' Club, January 14, 1915.

† Consulting Engineer, 17 Battery Place, New York.

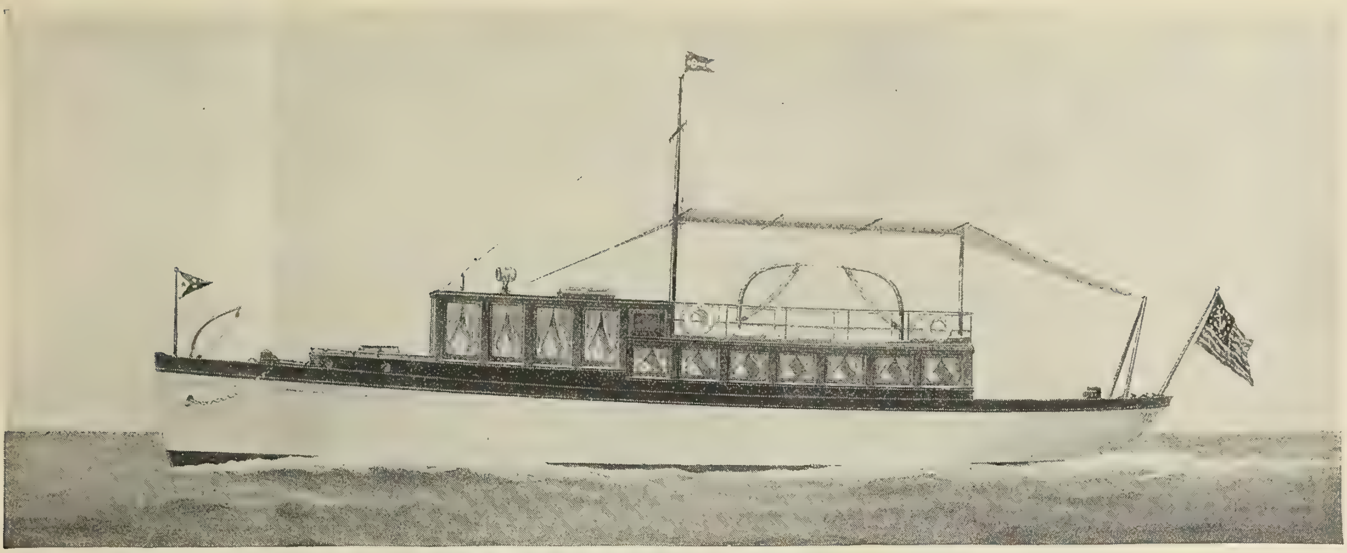


Fig. 3.—Fifty-Foot Motorboat *Dawn*, Equipped with Electric Drive

on waterline and a draft of about 4 feet. The *Dawn* was built by Hehre & Auer, Clason Point, New York. She was launched on August 7, 1914, and put into commission September 9, 1914.

In building, the greatest care was used to conform accurately to the designed lines, and such slight modification as was found necessary was very carefully noted. The lines shown in Fig. 1 are reproductions from the actual hull as built.

The power plant of the *Dawn* consists of a 60 horsepower gasolene (petrol) engine specially built by the Lamb Engine Company. This engine drives a 40-kilowatt generator of 450 revolutions per minute. A 4-kilowatt exciter of 750 revolutions is driven from the main generator through gearing. A 20-horsepower motor, with separately excited fields, designed to run at 450 revolutions per minute, drives the propeller. The excitation of the fields of the main generator and motor from the exciter constitutes the Ward-Leonard system of control, through which, by varying the excitation current in the fields of the generator, it is possible to deliver the full load amperage of the generator to the motor armature at any voltage up to 220, or even considerably higher, by increasing the speed of the generator. By the control of the voltage delivered from the generator as previously referred to, it is possible to run the motor with full load torque at any lower speed desired, it being understood, of course, that the reduction in speed would be in direct proportion to the reduction in voltage.

Fig. 5 shows a photograph of the power plant as it was built and assembled at the plant of the C. & C. Electric Company, Garwood, N. J., who furnished the equipment. The design was such that the entire plant could be assembled and tested in the shop and could be shipped as a unit ready for placing in the boat. The power plant was so located in the boat as to have the main engine and dynamo together with the exciter very readily accessible. The motor for driving the boat is placed forward and below the engine under the pilot house floor, the propeller shaft extending under the engine and generator and connecting through a thrust-bearing and flexible coupling to the propeller shaft.

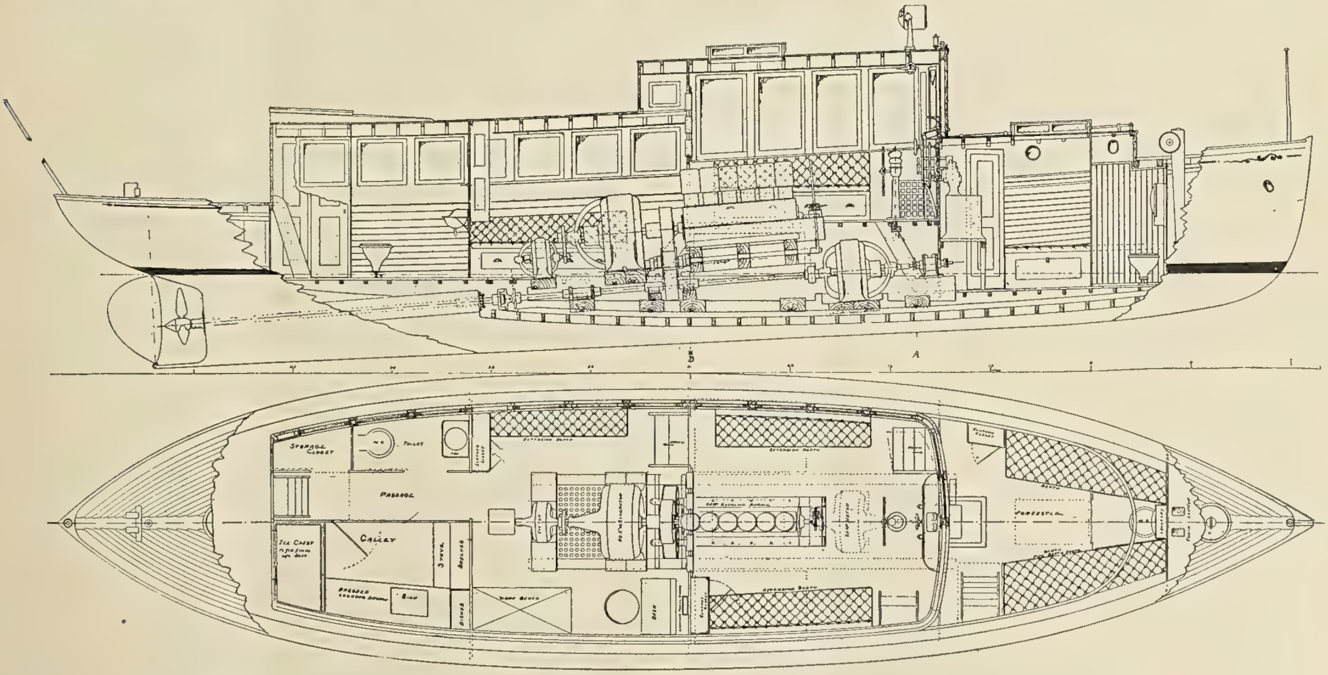


Fig. 4.—General Arrangement of the *Dawn*

The object for which the *Dawn* was designed was first, for the complete study of all the functions of electric power as applied to marine propulsion—that is, in addition to the power plant, the *Dawn* is supplied with every possible engineering device that can in any way facilitate the accurate determination and measurement of all the functions involved in the application of power to the propulsion of a vessel. At the same time the power plant is able to supply a surplus of from 20 to 30 horsepower for the propulsion of a second boat, and of course all the scientific devices referred to are applicable for determination of the power used in propelling that vessel.

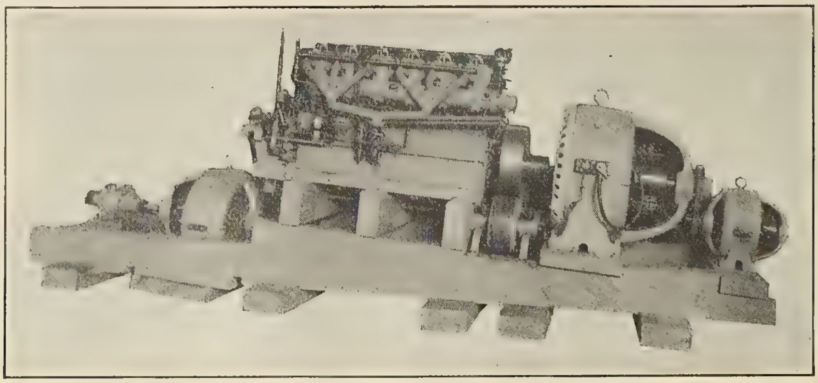


Fig. 5.—Power Plant of the *Dawn*

Details of the Propelling Plant

The 40-kilowatt generator previously referred to operates at a speed of 450 revolutions and 220 volts, and is direct-connected to the gas engine, the bearing next to the engine being omitted. It should be noted that the connection is made by a large flange to the flywheel, thus interposing the mass of the flywheel between the generator and engine to absorb any shock through sudden change of load. The outboard bearing of the generator is carried in a substantial bracket and turns on a ball bearing, reducing the friction to a minimum.

The generator is of the four-pole type, armature wound with copper bars built in slots. Very careful provision has been made both in the armature and generator for ventilation to increase overload capacity. Four interpoles are used to make commutation perfect under all conditions of load and field excitation. The field windings are arranged for separate excitation to provide for the delivery of current at any desired voltage which constitutes the principal feature of the Ward-Leonard system of control.

The 4-kilowatt exciter is driven by gearing from the main generator at a speed of 750 revolutions per minute. This machine is of rugged construction and liberal design, the armature being carried on ball bearings. The machine is of the four-pole type and is provided with a field regulator and compound field windings, so that it can supply a constant voltage for lighting and other purposes besides furnishing current for exciting the fields of the main generator.

As shown in Fig. 5, the 20-horsepower electric motor is directly coupled to the propeller shaft. This is a four-pole motor with separate field excitation, wound for 450 revolutions with 220 volts. Directly ahead of the motor (see Fig. 6) is a cylinder fitted with a piston arranged to revolve freely and to have a slight motion forward and aft. A ball bearing on each side of the piston is designed to take the thrust in either direction. To measure the thrust, oil is to be forced by a small hand pump between the cylinder head and piston, forcing the piston off the bearing, and the pressure of the oil is to read on the gage board to be described later in the article. It will be understood that a separate gage is provided to read the pressure on the piston in each direction.

With the characteristics of the generator and motor known, and with a record of the revolutions and thrust, the propeller efficiency can be readily determined.

Thrust Bearing

Referring to Fig. 7, there will be seen an auxiliary thrust bearing located on the motor shaft between the motor and the propeller. This thrust bearing was designed for use at times other than when experimental work was under way. It consists of a plain bearing lined with a metalline bushing, and on each end of this bearing is also provided a metalline disk. The bearing is 2 7/16 inches in diameter, 11 inches in length, and the disks on each end are 7 inches in diameter. The metalline bearing is a bronze bushing or plate bored with holes 3/8 inch to 1/2 inch in diameter, in which are inserted plugs of graphite. Attached to the shaft on each end of this bearing is a plain cast iron collar held with a key and set screw to prevent the possibility of end movement. No particular care was taken with the construction of this bearing or with the facing of the cast iron flanges. It will be understood that it runs absolutely dry without any provision whatever for lubrication or cooling, and while there was a slight tendency to heat when first put in operation, it was never sufficient to cause a shut down or to interfere with the operation of the boat under full power. During the latter runs the temperature was never greater than could be borne by the hand in contact with it. When it is realized that in this case all the friction must appear in heat and be conducted away by air cooling, it is apparent that the coefficient of resistance must be very low.

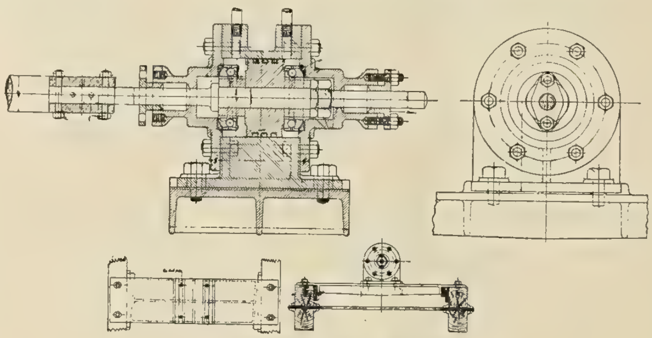


Fig. 6.—Thrust Bearing

It should be stated that metalline bearings are in no sense new, having been used for many purposes for the past twenty-five years; but so far as the writer is aware,

this is the first case in which an attempt has been made to use the device as a thrust bearing for a boat. While present limited experience is not to be regarded as conclusive, there seems to be very good ground for believing that it is possible to design a thrust bearing which would require neither oil nor attention. From all appearances the wearing qualities of this bearing would be everything that could be desired.

Flexible Coupling

As it was necessary to place the motor well forward, the propeller shaft was consequently unusually long, and

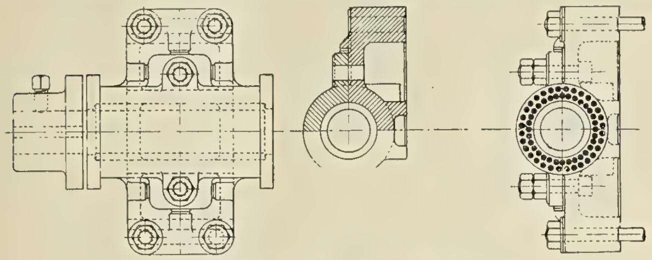


Fig. 7.—Auxiliary Thrust Bearing

it was deemed advisable to insert a flexible coupling to avoid any difficulty from this feature. As it was particularly desired to run the motor when uncoupled from the propeller shaft, it was found necessary to design a special flexible coupling, as shown in Fig. 8. This coupling contains all the functions of a universal joint, but has been greatly simplified by a design which allows for the pins to go entirely through from side to side. The central flange carries two sets of lugs on opposite sides and the flanges attached to the propeller shaft, each carrying a set of lugs. These lugs are bored for 1¼-inch straight pins. These pins are held in place by cotter pins. This device has given excellent results and has proved most satisfactory in operation.

The propeller shaft from the flexible coupling aft is of Tobin bronze and carries a propeller 36 inches in diameter by 26 inches pitch. A great deal of study was given to the proper location of the propeller, and for the finishing of the deadwood. (See Fig. 9.) It will be noticed that the aft bearing of the propeller is carried well out beyond the deadwood, and that a special bronze casting has been made to bring the deadwood down to a fine edge, or, in other words, to carry out the lines of the hull and

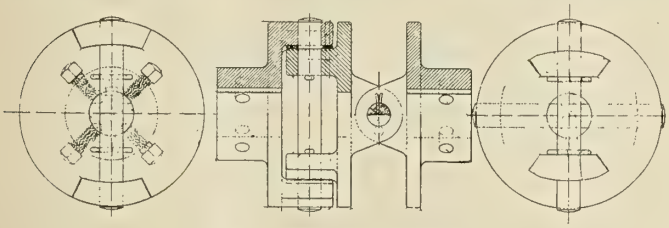


Fig. 8.—Flexible Coupling

deadwood in such a way as not to break up the water flowing to the propeller. There is reason to believe that a very considerable loss in efficiency of the propeller is due to the interference of the water flowing to it. In this construction the refinement referred to is so constructed that it can be removed, and with the facility for accurate measurement afforded by the power plant, an actual determination made as to the increased efficiency due to a careful construction of the deadwood.

The rudder design was carefully worked out along the same lines, and consists of a Tobin bronze rudder stem to which are attached bronze plates riveted around the edge, and as these plates are only 3/32 inch thick, the leading and aft edge of the rudder is only 3/16 inch thick, presenting a fine edge to the water.

Instrument Board

Perhaps the feature of the greatest interest in the equipment of the *Dawn* is the instrument board located at the after end of the pilot house over the engine. This board is about 4 feet square, and by reference to Figs. 10 and 11

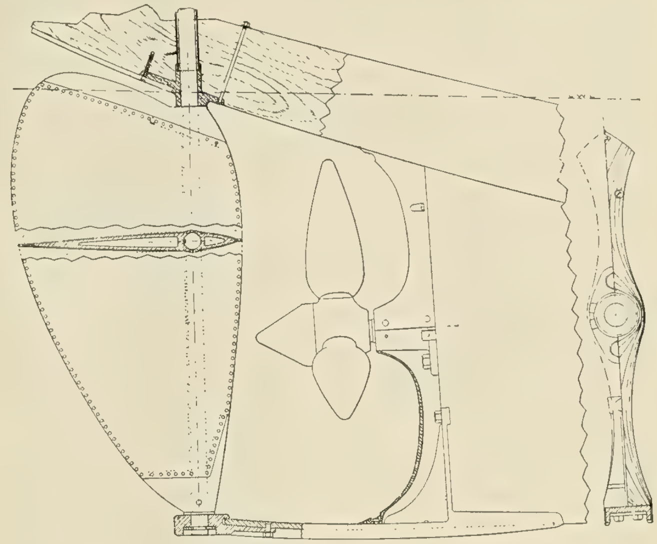


Fig. 9.—Position of Propeller and Rudder

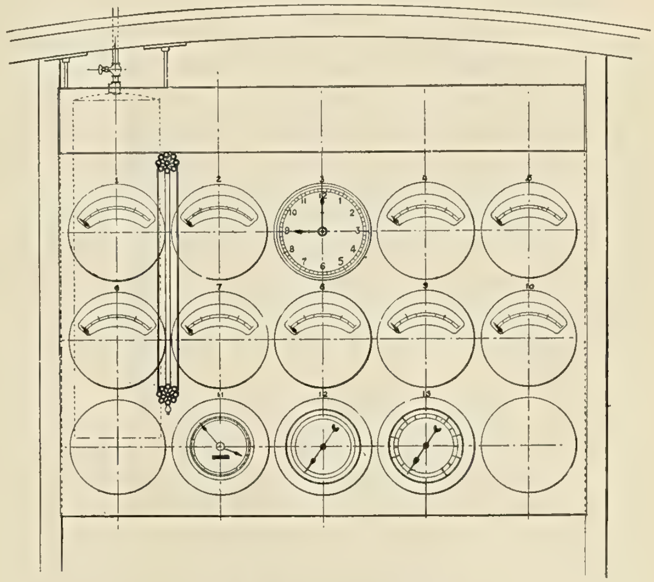


Fig. 10.—Instrument Board

it will be seen that provision has been made for 15 dial instruments; at the present time thirteen are in place. There is also a glass tube connecting direct to a feed tank for gasolene (petrol) on the rear of the board. At the upper edge of the board there is a space for such notation in lettering as will indicate the particular character of the experimental work under way. The instruments shown are: (1) and (2) ammeter and voltmeter for the generator, (3) a clock, (4) and (5) ammeter and volt-

meter for exciter, (6) and (7) ammeter and voltmeter for motor, (8) electric tachometer, reading revolutions of generator, (9) electric tachometer, reading revolutions of motor, (10) electric tachometer calibrated to read the speed of boat, (11) gasolene (petrol) meter measuring consumption of gasolene (petrol) between main tanks and feed tanks, (12) and (13) pressure gages registering oil pressure of the thrust bearing when going ahead and astern. There is also to be added to this board a U-tube to indicate Pitotemeter pressures as a check on the speed of the boat, and also in investigations of the distribution of water pressures about the hull of the boat when under way. Most of these instruments have been constructed specially for this plant, the electrical instruments by the Keystone Instrument Company, the meter by the National Meter Company, and the steam gages by the American Steam Gauge Company.

To record the reading of these instruments, a bracket is placed on the forward part of the pilot house for a camera and a photograph made of the board at time intervals, as indicated by the clock. (See Fig. 11.) The size and marking of instruments were carefully determined after photographs had been made, and it is to be understood that a 5-inch by 7-inch photograph of the board will give a clear and legible photograph of the reading of all the instruments. So far as the writer is aware, this is the first time that the camera has been utilized to facilitate and record accurate observations under test conditions. To facilitate the photographing, the lighting of the pilot house has been carefully considered, with windows on three sides and a skylight just above the board.

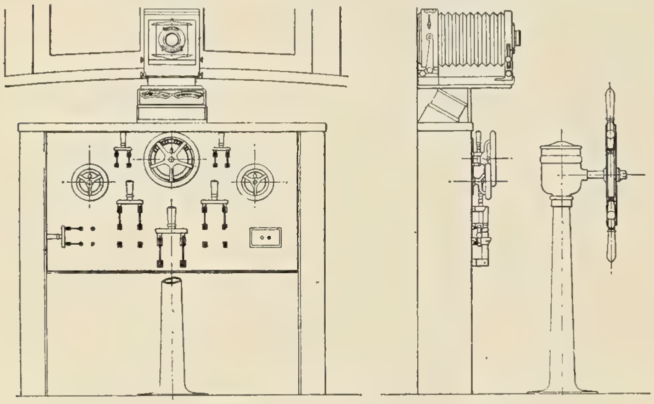


Fig. 11.—Switchboard, Showing Controls

Switchboard

The wheel for steering the *Dawn* is placed, as usual, in the forward part of the pilot house and directly in front of it is a switchboard giving complete control of the boat while under way. On this board, as shown in Fig. 11, are grouped a main switch for closing the motor circuit, a rheostat in the field circuit of the exciter, a rheostat in the circuit of the exciter, which supplies the fields of the main generator, and a rheostat cutting in resistance in the armature circuit of the motor. It will be understood that the rheostat in the field circuit of the main generator is so constructed that after cutting in resistance to a maximum amount and reducing the voltage to practically zero, a continuation of the rotation in the same direction will reverse the polarity in the fields, and continuation of the motion will cut out resistance. This makes it possible to reduce the speed of the motor and then reverse it by continual motion of this rheostat handle. The rheostat controlling resistance in the armature circuit of the motor is also double, so that when placed on the neutral point the motor circuit is open. Movement in either direction closes the circuit, starts the motor and cuts out resistance. In the practical operation of the *Dawn* I personally use a combination of both systems, —using the Ward-Leonard system to determine the maximum amount of speed to give the propeller and reversing with the ordinary rheostat in the motor circuit. It is, of course, possible to reverse the motor just as quickly as the rheostat handle can be turned, and in no case have I found the motor slow in response.

It will, of course, be understood that with a 40-kilowatt generator, a 20-horsepower motor, it is easily possible to get very much more than 20 horsepower for a short time out of the motor in either direction. This gives a very positive and powerful control of the situation.

One of the most pleasing things about the handling of this boat is to watch the various instruments and to be able to see exactly what is happening and what power is being consumed by the boat.

The *Dawn* was put in commission about September 1, 1914, which gave the writer what time he could afford in the next two months for testing out the machinery, and no time whatever in planning or getting down to real tests. The scientific work for which the *Dawn* is suitable is without limit. Of all the branches of naval architecture, the one relative to the design of screw propellers and their adaptability to ship propulsion is the most obscure and unsatisfactory. The electric propelling plant of the *Dawn*, together with the supplementary instruments and apparatus, is believed to be the most scientific plant ever devised for the practical testing of propellers.

Facilities for Testing Propellers

The method which it is proposed to follow is to obtain the drawing of a propeller in use on a line of steamers, and to build from the drawing a propeller of the correct size and pitch suitable for the *Dawn*, and then to test out its efficiency under various conditions of power and speed. A comparison of such tests, together with the best results which can be obtained by modification in the design, should give much positive information.

It is believed that with instruments and apparatus for determining accurately the speed and power applied to the *Dawn* and the hull resistance while under the action of the propeller, will give much more accurate and satisfactory information than is obtainable from tank tests of propeller efficiencies. It is also believed that very much can be learned relative to the influence upon the resistance of hulls in shallow water, in a confined waterway such as a canal, and in the currents of rivers where control and maneuvering power are important considerations.

The practical science of hull design for vessels depends upon the measured resistance of models obtained from towing them in a tank. It is a well-known fact that the propeller materially influences hull resistance. Just how and to what extent is more or less obscure. By designing a model of a large vessel to such a size that it may be driven at approximately the speed of the *Dawn* and supplying the power electrically from the *Dawn*, it will be possible to drive it with its own propeller; in other words, to reproduce in model form the exact conditions of the finished vessel and obtain accurate measurements of all the factors in the problem. By this method it is believed much definite knowledge can be added to the science of naval architecture.

(To be concluded.)

The Operation of a Marine Diesel Engine

Duties of an Engineer in Preparing a Diesel Engine for a Voyage—Starting Up, Maneuvering and General Operation

BY E. N. PERCY

Many marine engineers have made a fairly complete study of the Diesel engine, its principles and the results obtained, but even after the most careful study they find themselves confronted with the lack of knowledge which comes from experience alone. Such knowledge includes the preparation of a marine Diesel engine for a trip, starting it, reversing, general operation and details of maintenance. It is impossible for such information to be obtained by reading, but a sufficient number of points can be touched upon to indicate the precise character of experience necessary before a man can take intelligent charge of a marine Diesel plant.

For a given horsepower a marine Diesel engine compares favorably with a heavy slow speed steam engine of the same power. The maintenance of rods, bearings and thrust is practically the same except that the workmanship is much finer and brasses must be worked much closer.

The pressures are very high in a Diesel engine, running from 400 to 1,200 pounds per square inch according to the type of plant, but in consideration of the fact that for a given horsepower the cylinder is 1/3 to 1/5 the diameter of a steam cylinder, the rods and bearings are about the same size as in a steam engine of the same power, although disproportionate apparently to the size of the cylinder.

Workmanship

A Diesel engine is of much finer workmanship throughout—the bearings are fitted to 128th of an inch or closer. The pistons fit the cylinders very closely and are usually 1/100 inch smaller on top than at the bottom to allow for the expansion due to heat. Six to eight rings are used, having lapped joints, so that there is no possible leakage. Besides this a lubrication ring is used to maintain the film of oil between the main rings and itself.

Diesel engines are either two or four cycle. The valve mechanism in the four cycle engine is the finest mechanism imaginable and the fuel inlet valve, while built very heavily and operating against immense pressures, has a movement of only 1/16 to 1/64 inch and remains open from ⅛ of the stroke down to zero or the merest cut-off, the thickness of a sheet of paper, requiring mechanism of the finest workmanship and most exquisite adjustment.

The oil to these injection valves is pumped usually by a twin plunger, one plunger doing most of the work and discharging the excess oil through an escape valve back into the suction. The second plunger is somewhat smaller and accurately measures the amount of oil forced through the injection valve. On the largest engines these plungers are only about ¼ to ½ inch in diameter, and their stroke varies from one diameter down to nothing.

The oil is atomized by air pressure, varying from 600 to 1,200 pounds per square inch, according to the type of engine. This air is furnished by a three or four stage compressor sometimes attached to the main engine and sometimes to an auxiliary engine and in the more modern boats to both. The air from this same compressor is stored in steel bottles for starting purposes. The average marine Diesel engine carries enough compressed air to turn over for about ten minutes when starting.

The engines are absolutely reliable in starting and reversing provided that preparations have been careful and the inspection thorough. During a stay in port for some days the bearings and pins are overhauled very much as with a steam engine and the valve gear looked after in the same way.

Timing of Valves

The proper timing of the various valves is worked out for each engine by the designers and perfected by the builder during trials. These data are always available on a boat, or if not must be made available, so that when adjustments for changes due to wear or other causes are necessary the gear can be brought to its proper timing without guesswork. Suction valves usually open about five degrees below top center and close on the bottom center. Exhaust valves usually open about ten or twelve degrees below the bottom center and close somewhere near the top center, each on its proper cycle. All valves are closed during compression, expansion and explosion with the exception of the fuel inlet, which has a lead of from five to ten degrees or more according to the speed of the engine, the kind of fuel used and the type of injection valve.

Other factors also enter into this, such as the temperature of the fuel, its viscosity, the pressure of the atomizing air and the type of atomization and apparatus. Engines which have failed on certain kinds of fuel oil have been made successful by raising the pressure of the atomizing air or by pre-heating the fuel or in other ways improving the atomization. If an engine smokes and shows carbon deposit only one of three reasons can exist:

First: The fuel is not being atomized.
Second: The compression is not high enough.
Third: There is an excess of fuel.

If the fuel does not atomize it may be because the viscosity is too high. This can in some cases be remedied by pre-heating the fuel or increasing the amount and pressure of the air used for atomizing, but some of the heavier residual fuel oils are so viscous and have such enormous surface tension that it is absolutely impossible to atomize them into the fine mist necessary for clean combustion under these conditions. If the engine has not sufficient compression the only possible remedy is to use a lighter fuel more easily ignited, because the compression of a Diesel engine is the maximum stress; and as the engine is always designed for this stress it is not possible to increase it substantially without risking the entire structure, and subjecting the bearings to pressures per square inch in excess of those considered in the design.

Sometimes a small advantage can be obtained by speeding up the engine and thus obtaining high temperatures because of the smaller interval of radiation. Again it is possible to increase the compression in certain instances by putting in thicker liners and smaller pistons, thus reducing the bore and making possible an increase of compression. Practically all Diesels have removable liners which make this possible. If the engine is getting too much fuel the remedy is obvious and the method is to change the adjustment of the governor which controls the timing of the inlet valve.

The writer knew of one case where the bell crank connecting the governor to the inlet valve was reversed and the engine was governed and slowed down by the admission of excess fuel and a great deal of experimenting

was done to account for the abnormal behavior of the engine, the abnormal cards rendered and the great amount of carbon collecting in the cylinders.

Injection Valve

The injection valve necessarily passes through a long stuffing box, which has to withstand the entire pressure of the atomizing air 600 to 1,200 pounds per square inch. The valve is usually raised by cams and returned to its seal by powerful springs. Various devices have been resorted to to minimize friction in the stuffing box, permitting the valve to center on its seat and at the same time preventing it from battering its seat, a rather delicate problem, as the valve is usually only ¼ to ⅝ inch in diameter and the stem two to three feet long. Some firms use an oil lantern in the middle of the stuffing box. Others eliminate the stuffing box entirely, having instead a long stem about 1½ inches in diameter and 18 inches long, fitting closely into a sleeve and having oil grooves instead of packing.

These points have been touched upon at some length because the injection valve with its auxiliaries (pumps) and compressors) is the heart of a Diesel engine. The timing of the injection valve, its control by the governor and the timing of the fuel pumps are the most delicate adjustments on the Diesel engine.

The air inlet and exhaust valves are comparatively easy to set. Cams are usually keyed on to the shaft so they cannot be moved and, if movement is desired, an offset key is made. The only adjustment actually necessary is to compensate for the wear on the valves and this adjustment consists of nothing more or less than lengthening the stem of the valve by means of the sleeve placed there for that purpose until it is the thickness of a sheet of paper from the roller on the lever and the roller on the other end of the lever is taut on the cam, the valve being closed and the cam being down as far as it will go.

The adjustment of the injection valve, pumps, etc., is done with gages furnished by the manufacturers, who are always glad to instruct properly the man in charge. Besides the general work of taking up loose bearings, pins, adjustments, etc., it is customary to clean all valves and their seats and the cages inside and out. The cylinders are carefully cleaned at every opportunity and several times a year the pistons are removed, inspected and cleaned, broken rings replaced and the cylinder thoroughly examined. Marine Diesel engines usually are so designed that the pistons can be easily removed with a minimum effort.

Maintenance

In a general way the maintenance of a Diesel engine is not very different from a steam engine, inasmuch as all the work can be done by any first-class mechanic if properly instructed. One good Diesel man can take charge of a large marine Diesel engine plant in which there is not another Diesel man on board provided they are all good mechanics. In fact the writer knows of two instances where this was done.

When a Diesel engine has been overhauled thoroughly, inspected and adjusted it is ready to start. There are no preliminaries, no steam to get up, no starting of this, that and the other auxiliary, simply open the air valves and the engine starts. In practice aboard ship there is usually a Diesel dynamo engine in operation and a Diesel air compressor. The multi-stage air compressor has usually four stages and stores air at two pressures, one for starting and one for atomization. With the air in storage on a twin screw boat, two compressor engines running and one of the main engines compressing air as soon as it starts there is every chance of getting an engine under way even after several failures.

A new engineer coming into a dead ship that is supposed to be ready to run will first get the dynamos in operation, because practically all auxiliary machinery, such as ice machinery, blowers, hoist, etc., are operated by electricity on a Diesel boat. If the boat does not have even sufficient air stored to start the dynamo engine, a donkey boiler on the upper deck (which is required by law for pumping purposes) is fired up and a small steam compressor operated for several hours.

The next step is to start the auxiliary Diesel compressors. This can be dispensed with, if the main engines are merely being started at the dock, but if maneuvering, the auxiliary compressors should always be in operation, at least until the crew have become thoroughly convinced of the reliability of the main air stored and main engine compressors.

Inspection

An inspection of the main engines prior to turning over is somewhat similar to that of a steam engine. The crank pit and thrust are looked at to see that the gear has been cleared away and the turning motor disconnected. The main engine compressors are looked after in the same way and their discharge lines cleared to the reservoir—the pumps are worked by hand until the injection pipes and injection valves are filled as pet cocks on these valves will show. The air pressure for atomization is tested for atomization, note being taken whether the pet cocks throw solid oil or atomized oil. The jackets are tested for water and the various overflows from the jackets inspected to make sure that they are all running. The overflow from each individual water cooled valve is inspected.

The engine having been ascertained to be in condition to turn over, the air supply and the oil supply being checked at each injection valve, and it having been positively ascertained that each part of the engine is supplied with water, the engine is ready to start. A look at the gage board shows the pressure of the fuel oil supply, the atomizing air pressure, the starting air pressure, the jacket water pressure and the condition of the various auxiliaries.

Most Diesel marine engines have one set of cams for going ahead and another set on the same shaft for reversing and the shaft is moved end-wise to bring one or the other into play. In order to shift this shaft it is necessary to lift all the valves, otherwise their rollers would catch on the edges of the cams. A lever is provided for this purpose.

Starting Up

To start a Diesel engine the first step is to lift the valves, the next to shift the cam shaft forward or reverse as the occasion may require—the next is to lower the valves. Another lever is provided which causes the governor, when stopping a Diesel engine, to close off the oil injection valves, otherwise if the engine stopped with one of them open the cylinder would be filled with oil. Incidentally the only way a Diesel engine can be stopped is to shut off the oil supply.

The air valve is opened and the engine starts slowly. It turns more easily even than a steam engine because no warming up is necessary. After it has made about one revolution the governor lever is moved and the injection valves begin to act. The engine develops power instantly with the fresh injection. It is then operated very slowly indeed until the entire engine is well warmed up, because one of the greatest troubles with Diesel engines is the

cracking of the cylinder castings owing to the constant changes of temperature.

During this period a round of the engine is made to inspect the action of valves, try pet cocks, examine jacket water for temperature and otherwise make sure that the engine is operating sweetly. The engine should have a chance to operate twenty minutes in this manner, but if necessary can be brought up to full speed in four or five minutes, but should by no means be brought up to full speed immediately on start unless there is opportunity to circulate *hot* water throughout the jackets of the engine, as at least one installation has provided a connection from the donkey boiler to the jackets for the purpose of warming them up.

When under way if any of the valves give trouble a good Diesel man thinks nothing of removing them or changing them without stopping the engine. If an exhaust valve or an injection valve must be changed the inlet valve is propped open so that there is no compression in the cylinder and vice versa.

Selection of Fuel

Great care must be exercised in the selection of fuel for these engines, but it would be impossible to make specifications, because a fuel which one engine will use satisfactorily cannot be consumed by another engine having a different compression or system of atomization. It is an object to use the cheapest fuel possible but in a general way Diesel engines absolutely cannot use crude oils. The fuels which they do require are easily obtainable and cost very little more than crude oil. Most Diesel engines, as sold by the manufacturers, are guaranteed to use crude oil of a certain gravity, but this gravity is so high that there are very few crude oils in the world that will comply with it. When an engine is operated satisfactorily on an oil of a given viscosity, it is advisable to get fuel as near this viscosity as practicable, otherwise the entire adjustment of the injection valves must be altered. A still better way is to have a heater installed, possibly taking warm gases from the exhaust for the purpose of heating the oil. A viscometer for use on shipboard can be obtained for about $50.00 (10/8/4), and if the fuel oil happens to have more viscosity than desirable, enough heat can be added to it to bring about the proper consistency.

All told the Diesel is an easy engine to operate for a man who is a mechanic and an engineer, but if undertaken by a tinkerer he is sure to find himself in trouble soon because of the fine workmanship demanded in the proper maintenance of a Diesel engine.

Convention of the American Society of Marine Draftsmen

The fourth annual convention of the American Society of Marine Draftsmen, which was held at the Hotel Breslin, New York, on April 16 and 17, proved to be most successful from every standpoint and eclipsed all previous conventions of the society for the amount of work accomplished and the harmonious manner in which the proceedings were conducted.

The meeting was called to order by J. Emile Schmeltzer, president of the society, at nine o'clock on Friday morning, April 16, and the following delegates answered to the roll: Branch No. 1, Delaware River, R. N. Story; Branch No. 2, Norfolk Navy Yard, A. W. Chase; Branch No. 3, Boston Navy Yard, M. M. Blunt; Branch No. 4, Quincy, Mass., J. E. Buckley; Branch No. 5, Washington Navy Yard, Chas. Walsh and G. W. Nusbaum; Branch No. 6, Newport News, Va., S. Van Auken, A. H. Haag and H. A. Hope; Branch No. 7, Portsmouth Navy Yard, R. J. Boyd; Branch No. 8, Connecticut, A. C. West; Branch No. 9, New York, R. H. Stults and P. R. Hichborn; Branch No. 10, District of Columbia, W. L. Buckley and H. Capdevielle; Branch No. 11, Mare Island, W. B. Newton; Branch No. 12, Bath, Me., W. Murtaugh.

At the morning session the reports of the executive committee, delegates and the several standing committees were heard. The reports showed a healthy growth in membership, new branches having been established at Bath, Me., and Vallejo, Cal. There are, at present, three more branches forming in various parts of the country. The secretary's report showed that a large number of the members had secured positions through the inquiries of employers for men in this profession.

The afternoon session was devoted to unfinished business and the election of officers, which resulted as follows: President, J. Emile Schmeltzer, New York; vice-president, H. A. Hope, Newport News, Va.; secretary, B. G. Barnes, Quincy, Mass.; treasurer, P. K. Thurston, Washington, D. C.; executive committeeman, P. H. Frohwein, New London, Conn.

The Norfolk and Newport News, Va., branches of the society were successful in securing the convention for next year, and it is believed that Old Point Comfort will be designated as the place of meeting.

The second day of the convention was devoted entirely to new business, when various resolutions, having for their object the advancement of the draftsmen along intellectual and economic lines, were introduced and acted upon.

The convention closed with a banquet given in honor of the delegates by the New York Branch at the Hotel Breslin, at which over 200 were present, including men prominent in the field of naval architecture and marine engineering. R. H. Stults acted as toastmaster, and after welcoming the delegates and other guests, introduced the following speakers: J. Emile Schmeltzer, "The Society: Its Organization and Objects"; Luther D. Lovekin, "The Marine Draftsman"; Saunders Van Auken, "Brotherly Love"; Hon. James P. Maher, "Our Navy Yard"; Naval Constructor J. E. Bailey, "Our Battleships"; Postmaster Wm. E. Kelly, "Organization and Fraternalism"; and Hon. James V. Flynn, "In Passing." The banquet was a splendid social success and the festivities continued long after the formal programme was completed.

The object of the American Society of Marine Draftsmen, as outlined by the officers, is to unite the marine draftsmen and to promote their welfare socially, intellectually and professionally and to cultivate the highest standard of professional ethics. Meetings are held by the various branch societies at least monthly, and, together with the regular business, papers of a technical nature are read and discussed. These papers are published in the society's *Journal,* which makes its appearance quarterly, and, while it is only one year old, it has already taken a front rank among technical papers of its kind.

While the society is distinctly an intellectual body, yet the collective mind of the draftsman seems to have been asleep to general economic conditions until quite a recent date. It is only recently that he has awakened to the fact that he is his brothers' keeper, and anything he may do to benefit his brother draftsmen will not only react to his own good, but will advance the interests of every member of the profession. Through this organization draftsmen learn to know and respect each other, and by association and the interchange of professional ideas increase their efficiency, which in turn reacts to the benefit of the employer.

Notes on the Conversion of Cargo Vessels into Bulk Oil Carriers—II

BY F. K. RUPRECHT *

Tank Top

It would be impossible to retain the tank top intact in an oil vessel, owing to the leakage and collection of explosive gases which would make the vessel very dangerous. Large openings could be cut in the tank top and all parts liable to collect vapors opened up by air and drain holes. This method, however, is not satisfactory because it is very difficult to clear the intact sections of gas. It would also be impracticable to remove the entire tank top, because it is a very valuable strength member, and longitudinal strength is a great desideratum in oil-carrying vessels.

A method which, it is believed, would do away with the first objection and still leave a great amount of strength, is to remove all plating except a strip on the centerline keelson wide enough to take the vertical web stiffeners on the centerline bulkhead, and strips 8 to 12 inches wide on each keelson and on the margin plates. A strip one frame space wide can be left on one side of the transverse bulkheads. This forms the lowest horizontal stiffener to the bulkhead and therefore should be on the same side as the other horizontal stiffeners. This method will apply to the tank top throughout the oil tanks and cofferdams. In this arrangement we keep that part of the tank top which contributes most towards the strength of the vessel and does away with any pockets and ventilation troubles.

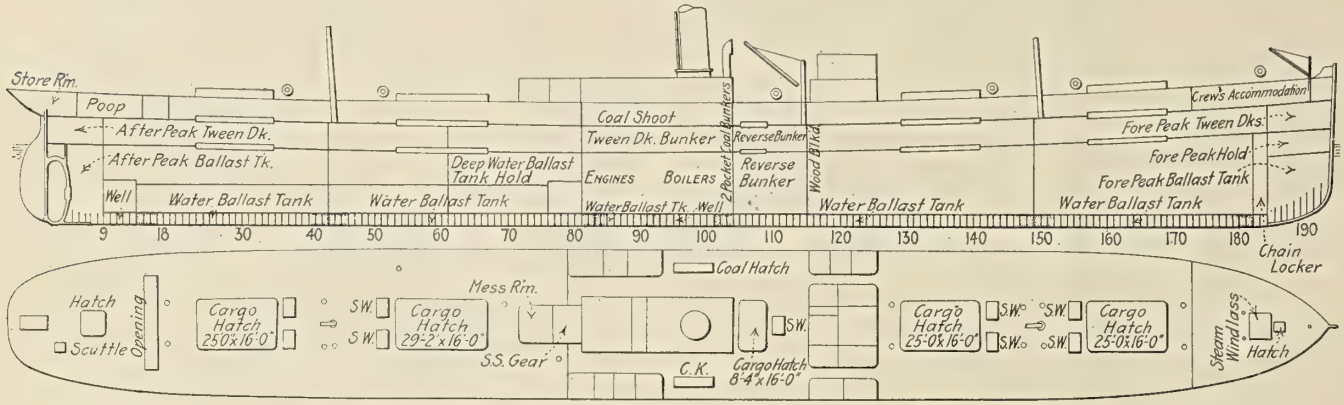


Fig. 1.—General Arrangement of Cargo Vessel Before Conversion to Oil Carrier

Construction of Web Frames

Two web frames will be fitted in each tank. In some cases the old web frames will be found adequate, and in this case no others need be fitted. In some of the tanks the web frames will not be found in a location suitable and in this case new ones will be added at the required frames.

The cost item will be the ruling one in the construction of these web frames, and it is believed that the cheapest construction is a single straight or tapered plate riveted to the margin plate bracket. The idea of tapering is to insure a good connection to the bracket. At the ends of the vessel the webs will be made up of two plates, because they could not be fitted in one length owing to the slope of the ship's side. The plate butts and the connection to the bilge bracket will be triple riveted. The connection to the shell will be by the ordinary frame bar and a 3½-inch by 3½-inch by ½-inch angle will be fitted on the other side. The larger angle will be double zigzag riveted and the smaller angle will take the outside row only. The face bars will be double bulb angles about 3 inches by 7 inches, giving a good heavy frame. One of the bars will be bent into the margin bracket and the other carried down over the butt, as shown in Fig. 5.

At the deck the web frame will be clipped to the deck by double clips and riveted oiltight, besides being bracketed to a deep beam, which in turn will be connected to a web on the centerline bulkhead. This forms two complete girders in each tank and gives a great amount of stiffness. Where the original web frames are retained special construction must be used to arrive at the same amount of strength. Web frames may have lightening holes cut in them, and where the straight plates are used this will usually be advisable, owing to excess weight.

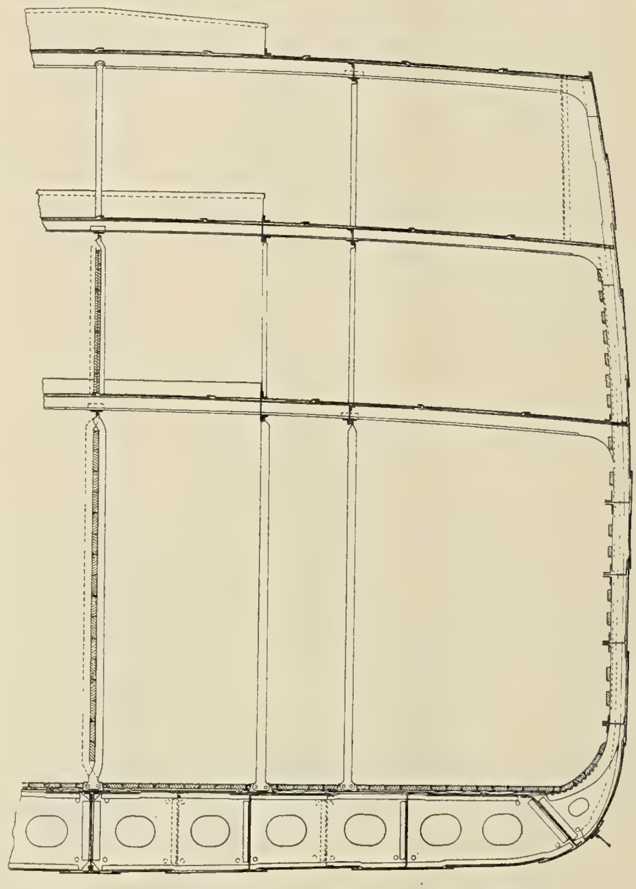


Fig. 2.—Midship Section of Cargo Vessel

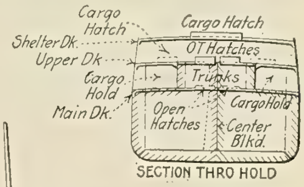
* Associate Member Society of Naval Architects and Marine Engineers.

The above method of constructing web frames recommends itself because of the small amount of riveting owing to the fact that most of the webs are in one piece. There is a saving in scrap material because no radii have to be cut at the bilge and at the inner edge of the plate. The old bilge bracket need not be removed and the face bars need very little, if any, furnacing. If, however, it is thought advisable to take out the old bilge bracket, the webs can still be fitted in straight lengths with a radius at the bilge. By fitting them this way the width will exceed that required by the registration societies, but a saving will be made in labor on the plate because of not having to shape the inner edge or furnace the face bars. The web will be connected to the margin plate by double clips and the riveting will be through the floor clips doubled if necessary.

In the 'tween decks the webs will be a flanged plate and will be riveted to the old shell bar and double or single double riveted clipped to the oiltight main deck and to the upper deck. Only the former clips will have to be riveted and calked oiltight, unless the 'tween decks are used as summer tanks.

Tank Deck

The tank deck will be oiltight from ship side to expansion trunk side. To do this the main frames must cut at the deck level, as stapling the deck angle around the frames would not be in accordance with the rules of the regis-



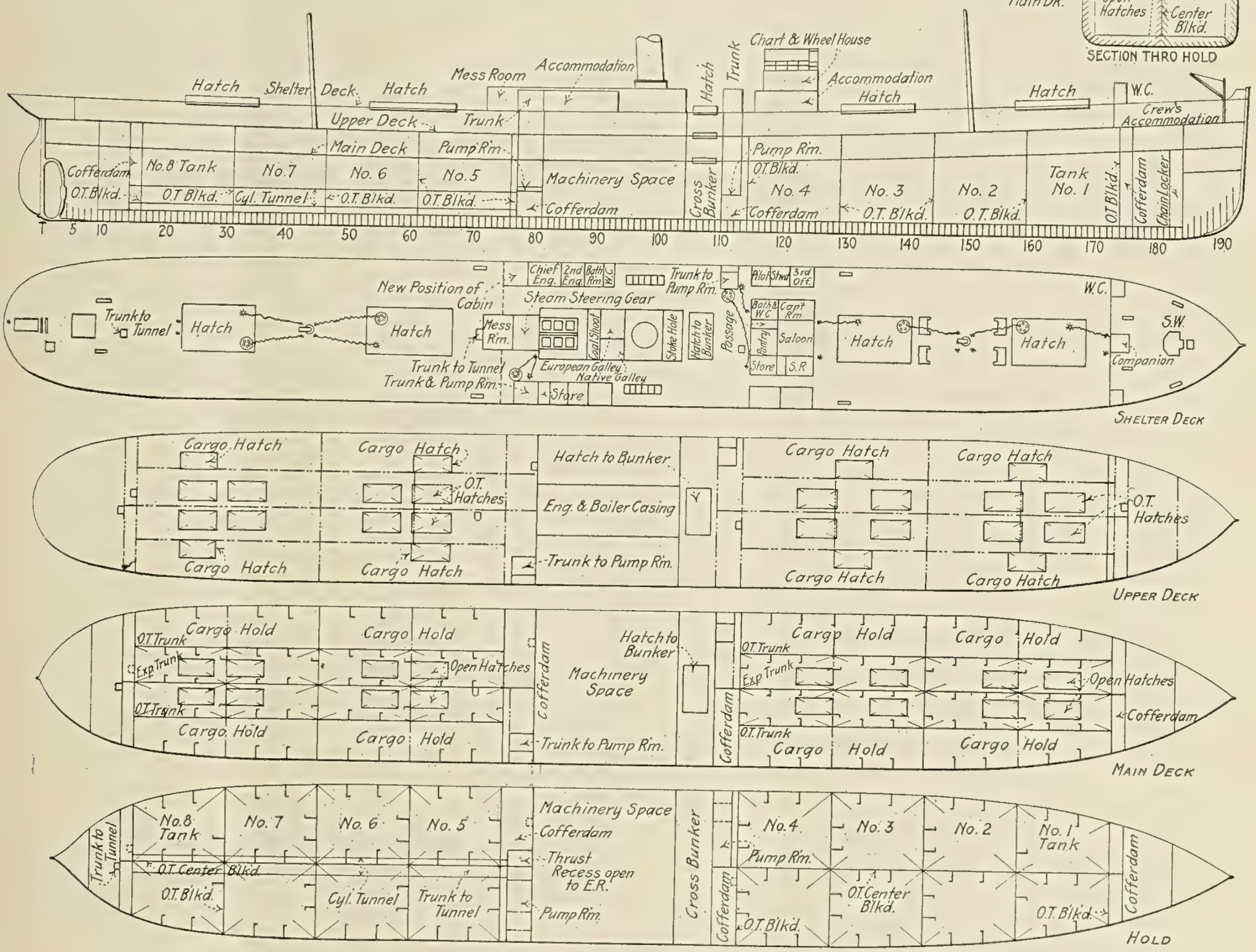


Fig. 3.—General Arrangement of Vessel as Bulk Oil Carrier

All stringers will be cut in the way of the webs, and if of a smaller depth will be bracketed to them. The brackets will have double clips to the web plate and will be double riveted to the stringer plate. These brackets may be flanged or fitted with a single face angle. If the stringers are of the same depth as the web frames, the stringer will be double clipped to the web or single clipped, but double riveted, which is preferred, and half diamond plates will be carried over the web frame face angles. The old stringers will be used, but will have to be taken down and cut to suit the bulkheads and frames. The brackets may be fitted to them while on the ground and the stringers replaced in section and reriveted to suit work.

tration societies and would not insure permanent tightness. The most economical method of doing this is to take the stringer plate off the deck and shear off the edge that had been notched in way of the frames. This takes about 6 to 8 inches off the plate. A section of the frame will be removed for about 10 inches above the deck level to allow for riveting the deck to the shell. The sheared stringer plate can now be connected continuously to the shell by a large double zigzag riveted angle or by a flanged plate. The latter will be easier to fit and rivet because the lap to the deck will be clear of the frames and easier to rivet and calk. With the flange plate it will be found easier to secure an oil tank connection to the shell, because the latter will be found slightly unfair and the flange plate

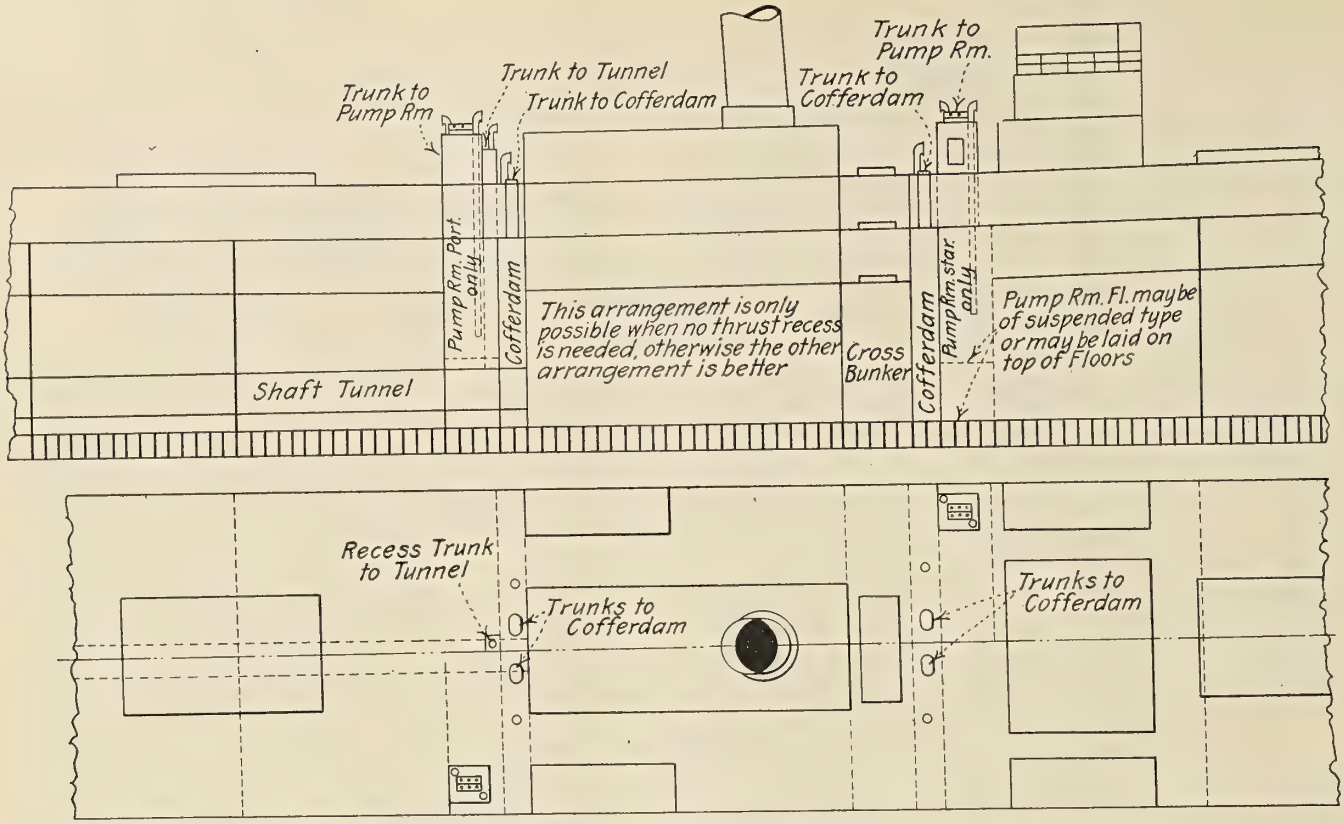


Fig. 4.—Alternate Arrangement of Pump Rooms and Midship Cofferdams

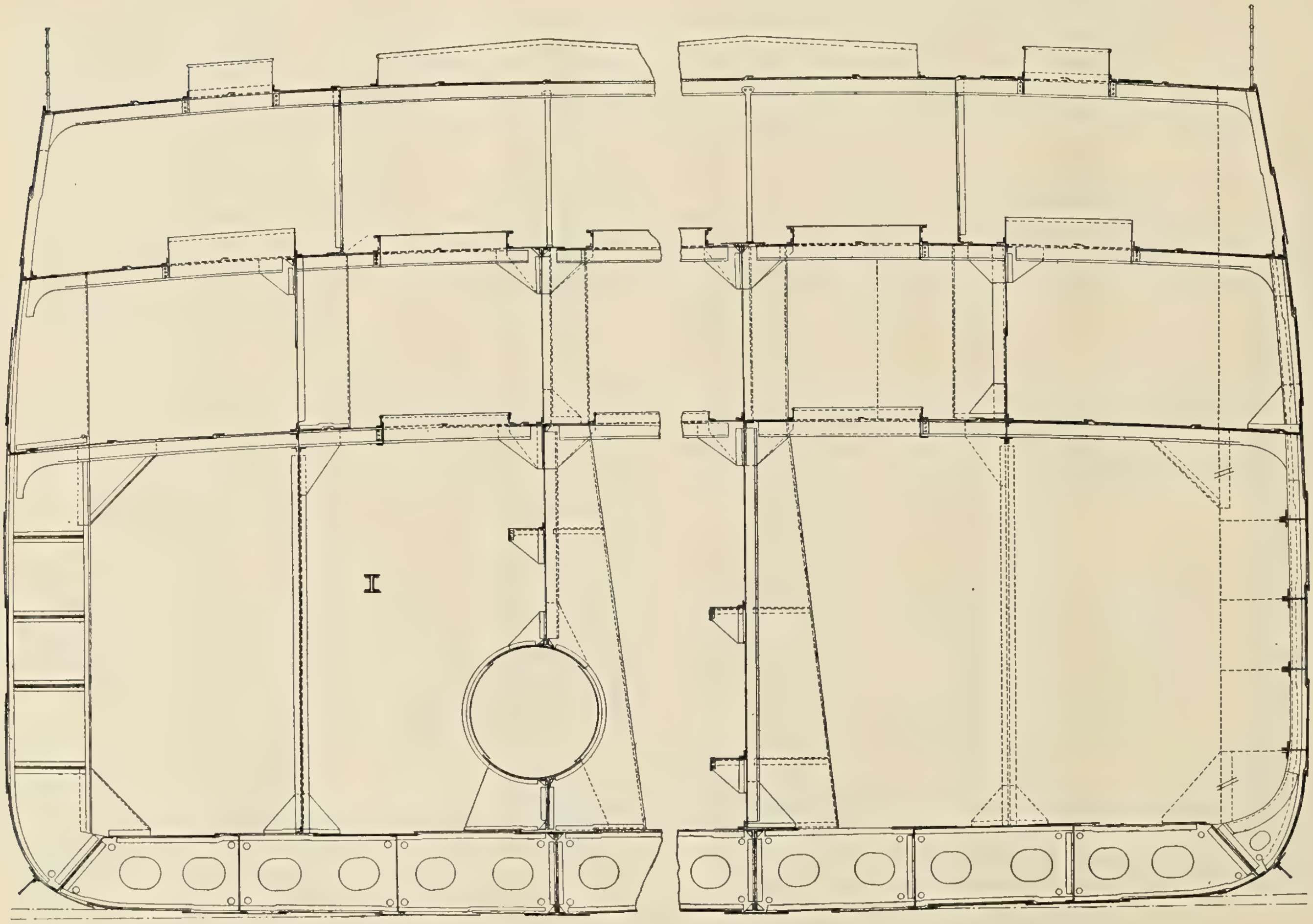


Fig. 5.—Midship Sections of a Cargo Vessel Converted into a Bulk Oil Carrier

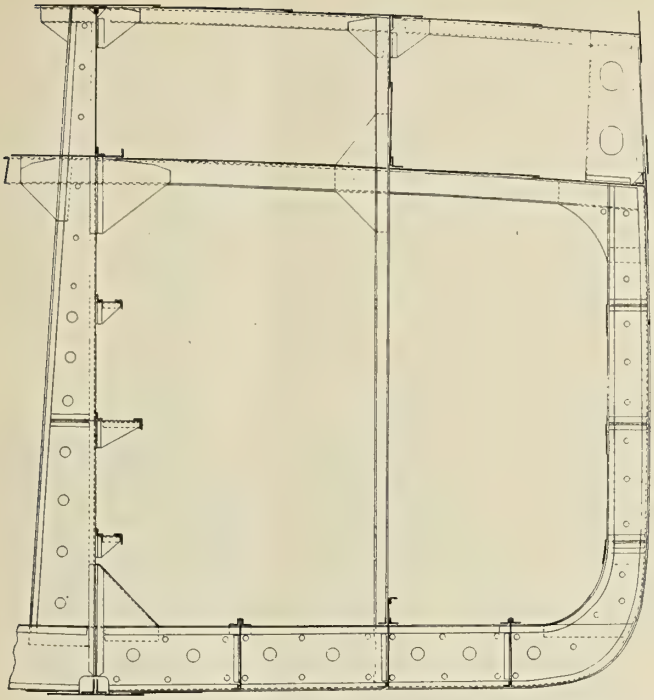


Fig. 6.—Midship Section of Vessel Built for the Oil-Carrying Trade

can be pulled up to it by the rivets better than a heavy angle. The angle connection reduces the width of the stringer plate, while with the flanged plate the original width can be retained by making the horizontal flange any desired width.

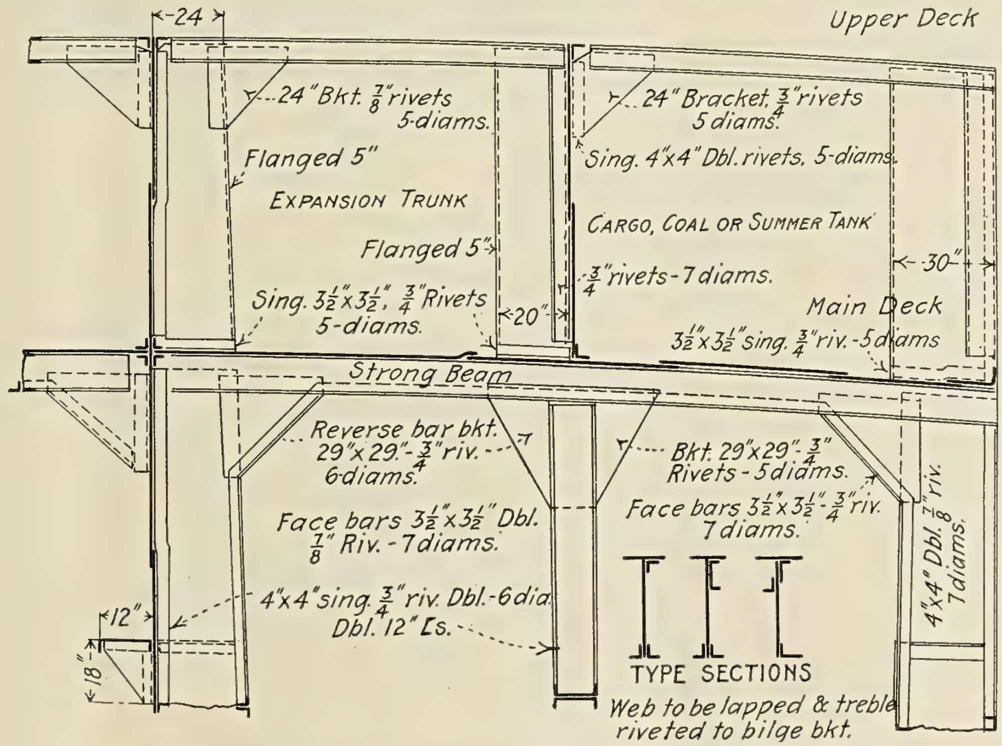
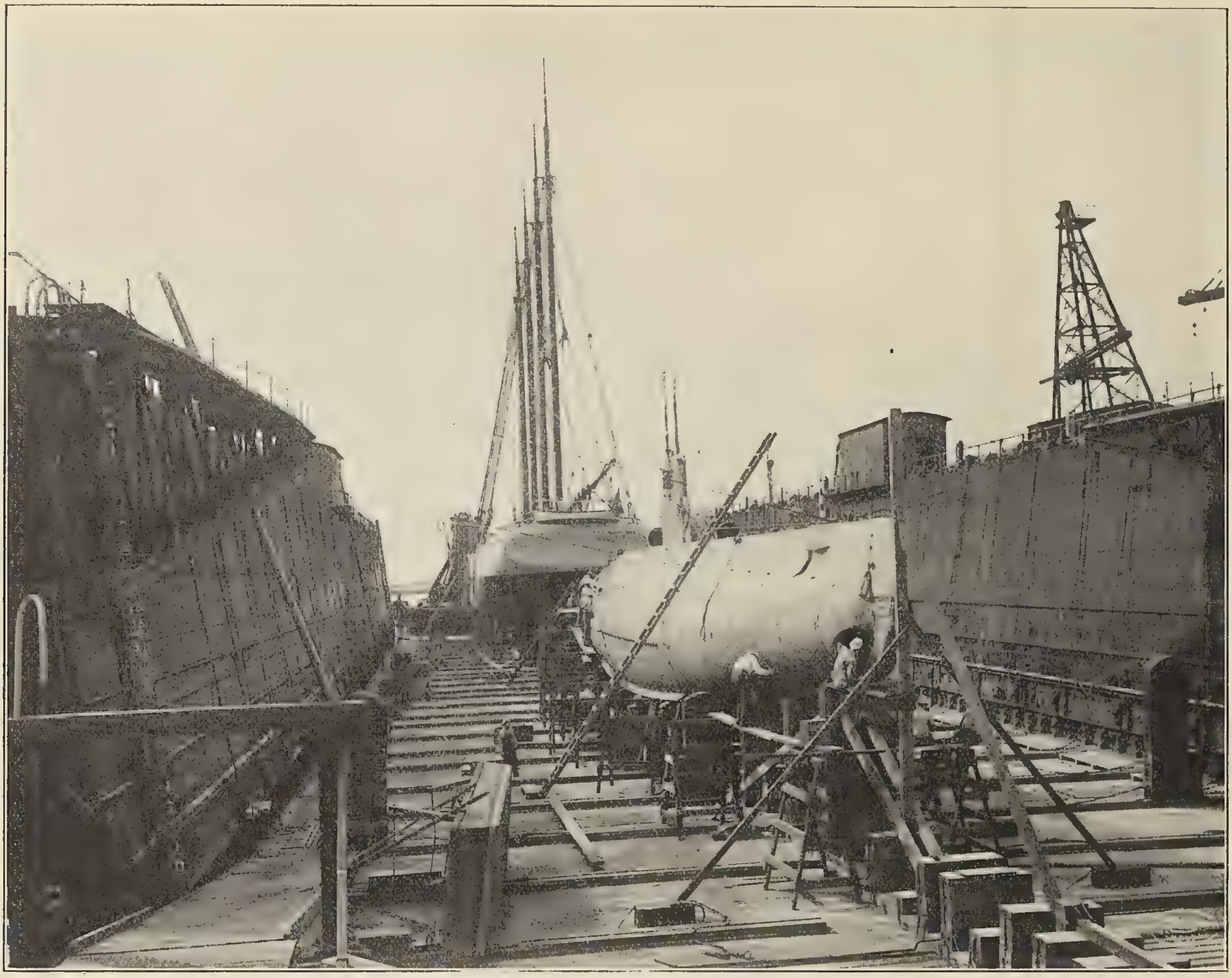


Fig. 7.—Section in Way of Web Frames, Showing Proposed Construction

Since this deck must be oiltight to the expansion trunk, all butts and laps will have to be double riveted. As a rule the original deck will be single riveted, so that all plates must be taken up and repunched for these extra rivets. The alternate strakes, of course, will have to be new plates to make up the width lost by the double riveted edge laps. Three strakes will, as a rule, be ample for the space between shell and trunk bulkhead. The stringer plate will be the original plate and so will be next, but a new strake will be fitted to take the trunk bulkhead. The edges must not be joggled because of the rules of the registration societies, so that in some cases the original plates must be put through the rolls before marking for the new rivets.

It will now be necessary to decide what to do with the deck in the expansion trunk. It can be left as it is and hatches cut in it to correspond with the oil hatches on the upper deck, the old cargo hatches being plated over, or the deck may be entirely taken up. In the latter case the beams may be left continuous to the centerline bulkhead and bracketed to the latter or cut at the expansion trunk edge. In this case, if the trunk bulkhead is stiffened on the oil side, the beams will project beyond the bulkhead far enough for a bracket connection from the vertical stiffeners on the bulkhead, or, if desired, the beams may be cut at the bulkhead line and the vertical stiffeners extended below the deck level far enough for a bracket connection to the beams as shown in the sketches. If the deck is stopped at the trunk the connection to the trunk bulkhead may be made by a large angle double zigzag riveted, or by a flanged plate similar to the connection at the shell. Since the bulkhead and the deck strake are new work the angle will be found very satisfactory.

If the deck is left intact, the vertical stiffeners on the expansion trunk bulkhead will be bracketed to the deck. If the deck is entirely removed, we introduce the complication of having to make the centerline and all transverse bulkheads continuous to the upper deck in the expansion trunk. What would seem a good compromise, since it includes the advantages of both methods, is as follows: Beams cut for centerline bulkhead, but left continuous from shell to centerline; deck made oiltight as outlined above, but continued beyond the expansion trunk bulkhead far enough to form a shelf about 2 feet wide for the connection of the stiffener brackets and the web stiffeners.



United States Submarine *F*-4 in Honolulu Drydock Just Before Starting on Her Fatal Cruise

This ledge would be carried entirely around the tank, forming a connection for the longitudinal and transverse bulkheads and the brackets of their vertical stiffeners, which will be cut at this level. At the centerline the shelf will be about 2 feet on each side of the bulkhead and the beam ends will be riveted to it and bracketed to the vertical stiffeners on the bulkhead. A corresponding strip of plating will be riveted to the strong beams, thereby increasing their stiffness. Small drain holes will be cut between all brackets all the way around the tank to avoid the collection of small quantities of oil. A large face angle will be riveted to the ledge to increase its stiffness, except at the transverse bulkheads, where the plating will be riveted to the next beam on each side.

Lloyd's rules for tank vessels require this shelf of plating at this level, two frame spaces wide at the centerline, for the connection of the centerline bulkhead and stiffener brackets and one frame space wide each side of the transverse bulkheads. None is, however, required at the trunk side, but the fitting of it seems to justify itself on a conversion job by the simplification of construction. In tank vessels only the strong beams in line with the web frames are carried to the centerline bulkhead, but in a conversion job where we have the beams we can get a stronger and cheaper job by keeping them in place.

While the deck plating is a great factor in longitudinal strength, we can afford to remove such large sections of this deck, because it is located close to the neutral axis of the vessel, and so the few strakes removed have but little effect on the moment of inertia, and the slight amount lost is more than made up for by the four angles on the centerline bulkhead, the face angles on the ledges, and the expansion trunk angle, all of which are continuous members.

(*To be continued.*)

Loss of Submarine F-4

Through the courtesy of Mr. James A. Lyle, superintendent of the Honolulu dry dock of the Inter-Island Steam Navigation Company, we are able to show on this page what is probably the last photograph ever taken of the United States submarine *F*-4 before she took her fatal plunge outside of Honolulu harbor on March 25. The submarine is shown docked in the Honolulu dry dock with the four-masted schooner *Defender*, receiving a final overhauling before beginning practice maneuvers.

According to reports from the commandant of the naval station at Pearl harbor, the salvage operations have progressed slowly, due to the depth at which the *F*-4 is submerged. Although nothing definite is known regarding the cause of the disaster, it is surmised that the crew must have been the victims of an explosion within the ship, as no signals of any kind were given after the vessel took her fatal dive.

The loss of the *F*-4 is the first serious submarine disaster in the United States Navy. The records at the Navy Department show, however, that the total number of submarine disasters in other navies up to date is sixteen.

The Craig Diesel Type Marine Oil Engine

Description of a Four Cycle Diesel Engine, Distinctively American in Design and Construction—Its Application to Commercial Boats

Sufficient data are now available from a variety of sources to show with a fair degree of certainty what can reasonably be expected from the performance of well-designed Diesel marine oil engines. The shortcomings and limitations of this type of machinery are much better understood than was the case a few years ago, and, on the other hand, the exceptional advantages of the Diesel engines are becoming more fully recognized and the field for its development is rapidly widening.

At the present time the superiority of the four-cycle Diesel engine is generally acknowledged, and its continued success, as marked by the increase of orders in England and on the Continent for vessels equipped with this type of machinery, seems fully assured. In the United States, where a general policy of "watchful waiting" has been adopted by shipowners in the matter of investigating the merits of the Diesel engine, a few pioneers have taken matters into their own hands, and in spite of the seemingly hostile attitude of shipowners have worked out their own designs and built engines of this type which have given very creditable results in service and which are likely to become an important factor in the marine engine field.

One of the distinctively American Diesel marine engines is illustrated on this and the following pages. It is of the four-cycle type built by the James Craig Engine & Machine Works, Jersey City, N. J., and shows in every detail the same thoroughness in design and workmanship that has marked the large gasoline (petrol) engines developed so successfully by this firm. The particular engine illustrated is a six-cylinder unit with a bore of 9½ inches and a stroke of 11 inches, designed to develop 175 brake horsepower when operated at about 400 revolutions per minute.

Two six-cylinder engines of this size were installed last season in the motor boat *Aeldgytha,* built by the Matthews Boat Company, Port Clinton, Ohio, from designe by Morris Whitaker, Nyack, N. Y., for cruising purposes on the Great Lakes. The boat is 110 feet long overall and 18 feet beam, with a draft of 6 feet. This is the first twin screw Diesel engine installation made in the United States.

During the last season the *Aeldgytha* cruised 2,400 miles with a fuel cost of only $120 (£25), whereas during the previous season, when the boat was fitted with gasoline (petrol) engines and made a total run of only

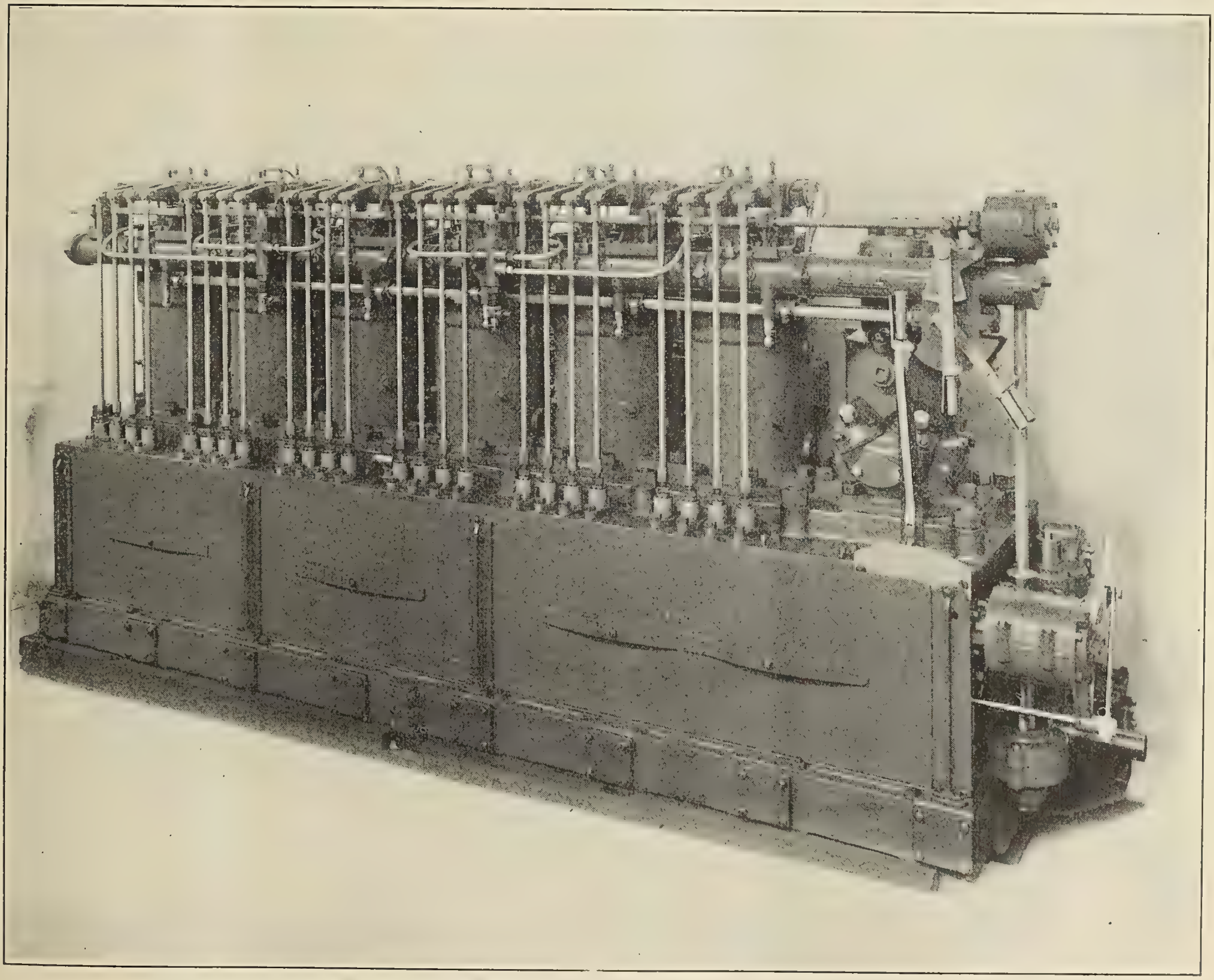


Fig. 1.—Craig Six-Cylinder Diesel Type Marine Oil Engine

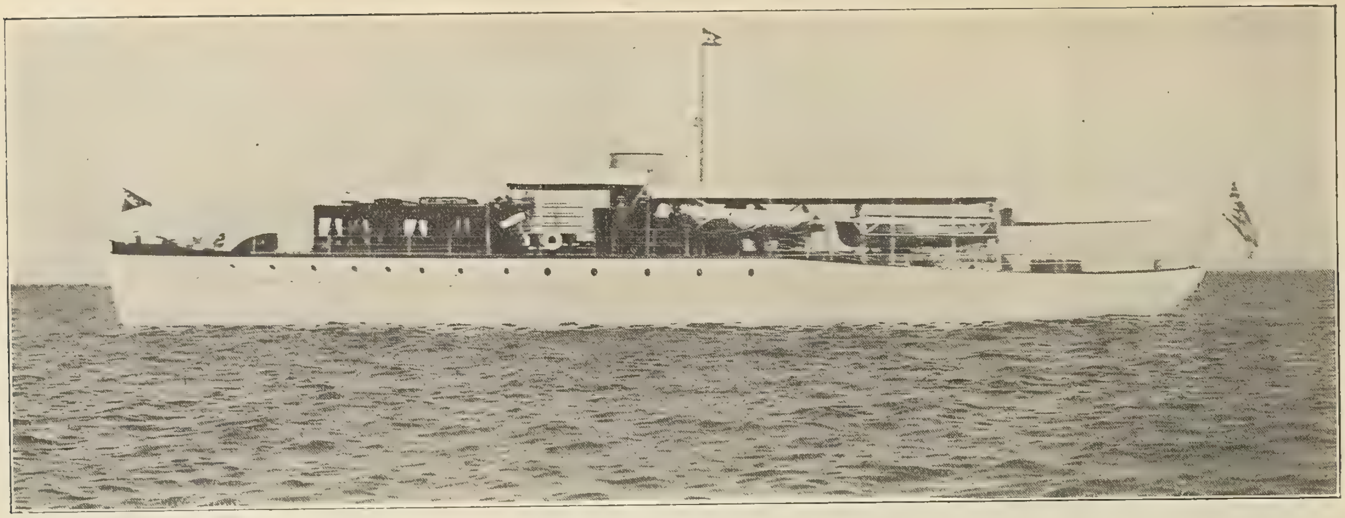


Fig. 2.—Diesel-Engined Motor Boat *Aeldgytha*

1,600 miles, the fuel cost was $550 (£113). With the Diesel engine installation the total cost for fuel and lubricating oil for the 2,400 miles traveled was only $175 (£36). The average fuel consumption with the engines running at about 330 revolutions per minute and giving the boat a speed between 11½ and 12 miles per hour, was a little less than one gallon per mile, or about .5 pound per brake horsepower per hour. By installing Diesel engines the cruising radius of the boat was more than doubled and the danger attending the presence of a large quantity of gasoline (petrol) on board was wholly eliminated.

The Craig engine has a number of very desirable features incorporated in its design. The framing is built up of steel columns carried down through the bedplate and

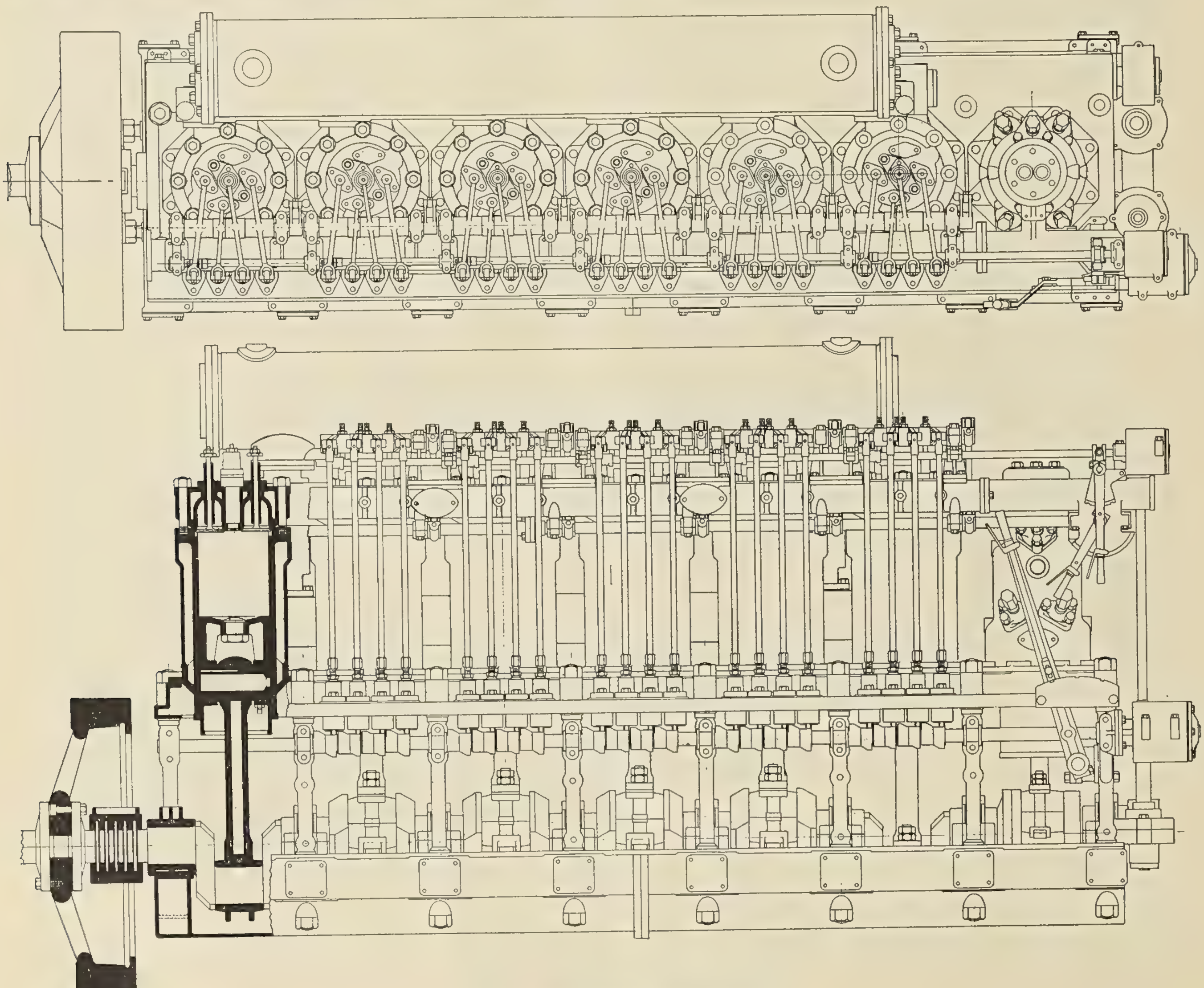


Fig. 3.—Craig Diesel Type Engine

stayed with diagonal bracing. The bedplate is a steel casting with hollow box girders through which the water for cooling the cylinder walls and heads and the main bearings is circulated. Above the column framing is an upper or "super" base carrying the cylinders and valve push rod guides.

In handling the exhaust a very ingenious arrangement is used consisting of an auxiliary exhaust valve operated by a separate cam shaft so timed that the valve is opened before the piston uncovers the exhaust ports in the cylinder walls at the bottom of the stroke. In this way over 80 per cent of the exhaust gases at high temperatures pass out of the cylinder before the regular exhaust valve in the cylinder head is opened. The regular exhaust valve, therefore, is not opened against high-pressures, nor is it subjected to highly heated gases; its function is simply to permit scavenging the cylinder.

With the exception of the auxiliary exhaust valve, all of the valves are mounted in the cylinder head. The air inlet valves are operated in the same way as the exhaust valves, but they are all connected to a common manifold which can be connected to the bilges, thus aiding in ventilating the bilges and at the same time supplying cold air to the cylinders. The air-starting and fuel injection valves are operated in a similar manner, but their rocker arms are mounted on eccentrics carried on a fore and aft shaft which by partial rotation will throw either one or the other of the valves in or out of action, as may be desired, in starting the engine. The fuel valve itself opens downward and the oil and injection air are thoroughly mixed and atomized in a series of washers perforated with small holes surrounding the valve.

Reversing is accomplished in the usual manner by shifting the main cam shaft, bringing the proper cams into action. In starting the engine, the air-starting and fuel injection valves are controlled by two levers connected by gearing to two control shafts, one mounted outside the other in the form of a sleeve, each of which controls the valves for three of the cylinders. A single oil pump supplies the oil to all injection valves, the openings in the separate feed pipes being controlled by separate needle valves and check valves.

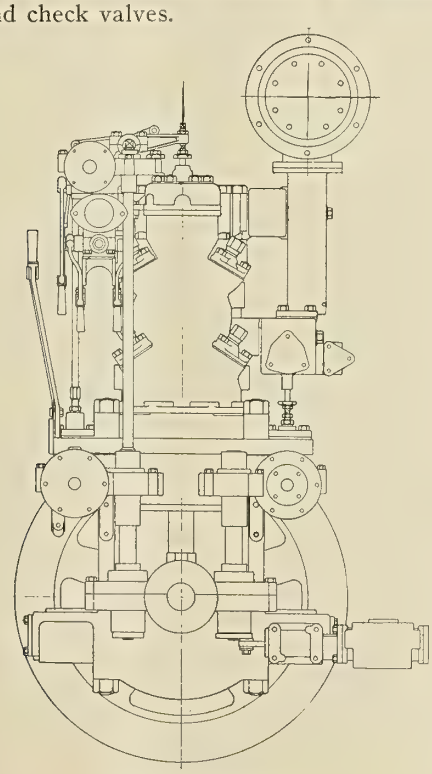


Fig. 4.—End View

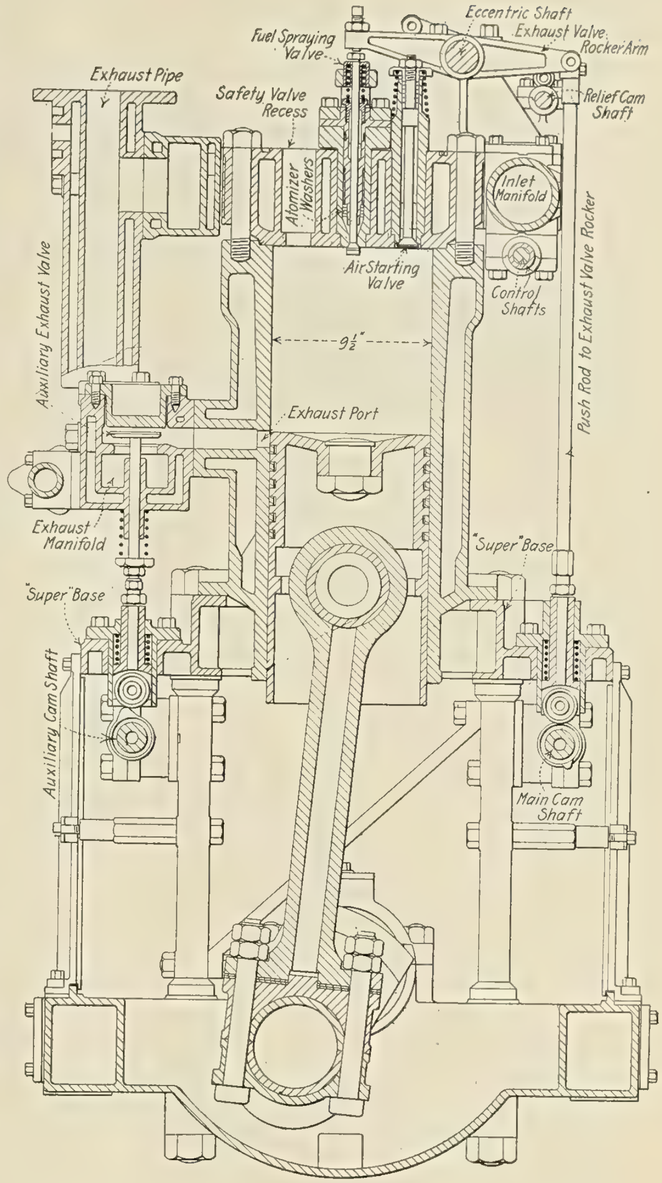


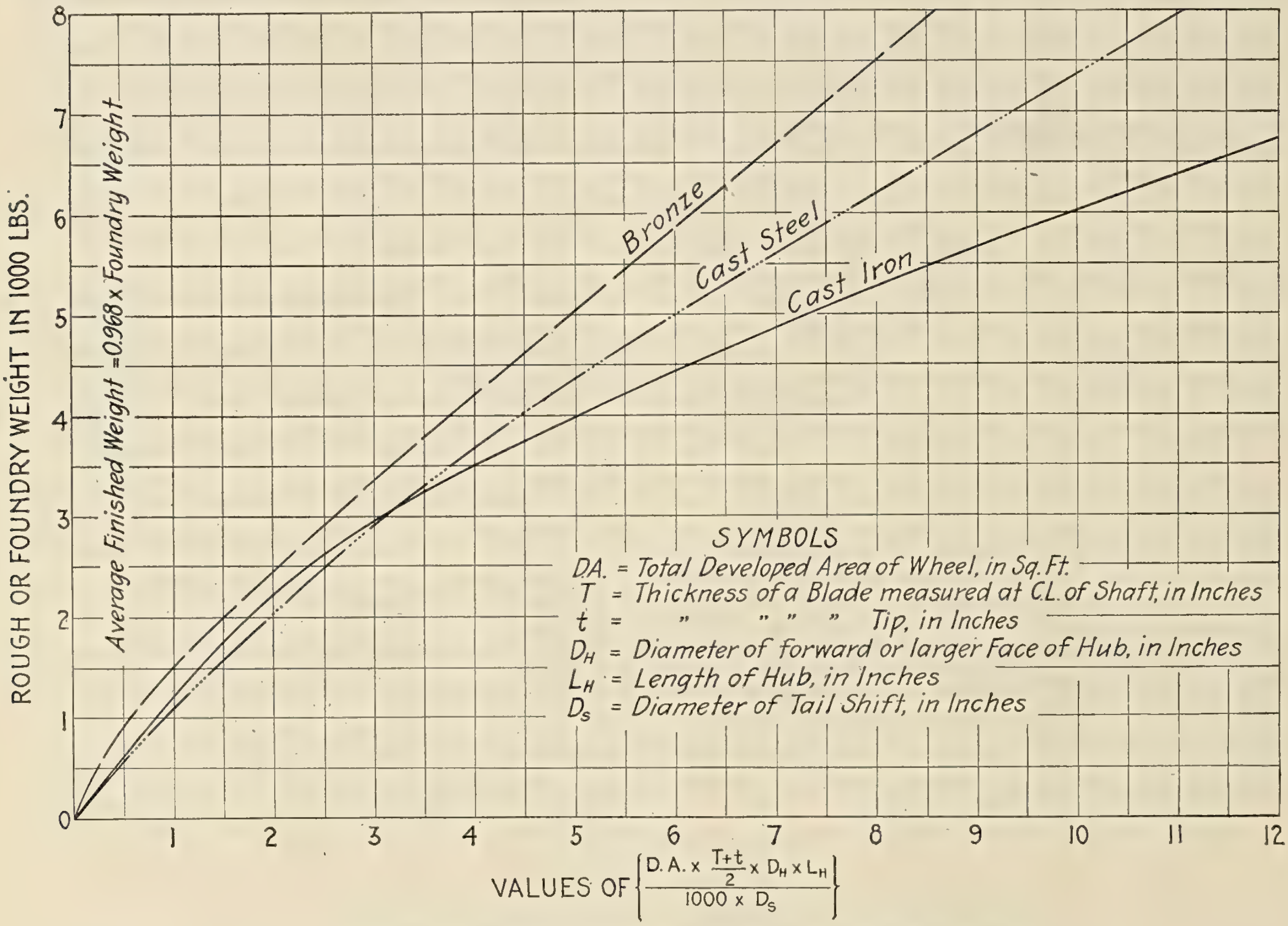
Fig. 5.—Cross-Section

The air compressor is of the two-stage type mounted on the main crankshaft with a very effective system of intercoolers. The builders also supply an auxiliary gasoline (petrol) engine-driven set comprising a two-stage air compressor, an electric generator and a bilge pump.

While from the point of view of economy and safety this type of engine is well adapted to yacht and pleasure boat service, as instanced by the satisfactory performance of the twin screw installation on the *Aeldgytha,* nevertheless its greatest field of application will undoubtedly be in commercial boats. Here the economy in fuel consumption, averaging not over .5 pound per brake horsepower per hour, coupled with the reliability of performance which can be justly claimed, makes it possible for a motor vessel to undertake long voyages without refueling, thus giving the owners an opportunity to take advantage of favorable markets for the supply of fuel. Moreover, in the case of the Craig engine, simplicity of design in accordance with the best engine building practice has made it possible to put the engine on the market at prices that compare very favorably with those of steam power plants, and in accomplishing this it is believed that one of the most serious drawbacks to the adoption of Diesel engines in commercial boats has been overcome.

Weights of Solid Four-Blade Propellers

The writer had occasion at one time to collect some data on the foundry and finished weights of various solid, four-blade, cast iron, bronze and cast steel propeller wheels. As complete dimensional data accompanied these weights, it seemed as though a law or formula might be developed which would give with sufficient accuracy the weight of a wheel for both cost-estimating and design purposes. After several different formulæ were tried, the following was finally adopted as giving the most accurate approximation, and still not being unwieldy.



Curves Showing Rough or Foundry Weights of Solid Four-Blade Propeller

The foundry or rough weights were plotted on:

$$\frac{DA \times \frac{T+t}{2} \times L_h \times D_h}{1{,}000 \times D_s},$$

where DA = total developed area of wheel, in square feet.
T = thickness of a blade measured at center line of shaft, in inches.
t = thickness of blade tip, in inches.
D_h = diameter of forward or larger face of hub, in inches.
L_h = length of hub, in inches.
D_s = diameter of bore for shaft at forward or larger face, in inches. Appraximately equal to the diameter of the tail shaft, in inches.

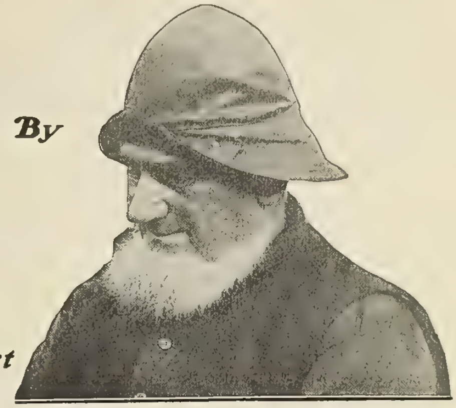
The foundry weights, or the weight of the wheel when turned out from the foundry ready for machining and boring, were used, as the finished weights varied much more, depending on the amount of machining done, and on the size of the cap fitted, etc. It was found that as a general average the foundry weight was about 3 percent greater than the finished weights when no caps were fitted. The foundry weights also varied somewhat, however, due to the difference in ramming in the foundry. Two 4,000-pound wheels (cast iron) cast from the same pattern, but rammed by different molders, were found to differ by 240 pounds. So it is very probable that a curve plotted on this formula will come within the limits of uniformity of actual weights.

The factors going to make up this formula are those found on practically every wheel design. Three curves are shown; one for cast iron wheels, one for bronze, and one for cast steel wheels. Although the writer had not the available data, no doubt the weights of built-up wheels and also three-blade wheels could be plotted on this same base. It is advised that any readers having sufficient data actually plot their own results, to allow for any variations in weights due to any local standards in design.

Seattle, Wash. L. A. BAIER, N. A.

LONG NON-STOP RUN OF MOTOR SHIP.—The motor ship *Selene*, of the Anglo-Saxon Petroleum Company, Ltd., fitted with Werkspoor Diesel engines, recently made a non-stop run of approximately 9,000 miles from Panama to Tientsin in forty-four days, averaging a speed of 200 miles per day. The vessel left Cardiff December 19, arriving at Port Arthur January 13. After loading, she left Port Arthur January 21 and arrived at Colon January 28, leaving Panama for Tientsin January 30. The latter part of the voyage was made without touching at any intermediate ports.

Economy Talks By "Old Scotch"



Savings That Can Be Made When a Vessel is in Port

There is an old saying that "Charity begins at home," and our old friend, Economy, likewise should begin at home. That is, don't practice it while you are away all the time, and neglect it at your home station.

To get down to what I'm aiming at, in connection with economy on board ship, all the saving should not be made while the ship is underway, but it should be practiced while tied up at the wharf, or at anchor as well. Even if the big mill is stopped, there are certain auxiliaries which must be kept going under all circumstances, and they require steam. Hence, fires must be maintained in at least one of the boilers, and that takes coal, and a lot of it, too, unless you carefully watch your corners to reduce waste.

Generally, when using one of the main boilers for auxiliary purposes, you do not need its full power for the work to be performed. Here is where you can make a saving. If it's a Scotch boiler with three furnaces, you can generally get along with the fire in only one furnace, or perhaps you might find it better to use one-third of your grate surface in each furnace. Whichever way you do it, stop all your air inlets, except those through the grate bars, immediately under the spread fire. You don't want to waste your heat units by raising the temperature of a lot of surplus air. Hence, go around and stop up all chinks where the air might sneak in with little dabs of fire-clay, and you will be surprised to see how you can cut down the coal consumption.

When I was a boy I knew the skipper of a Down East schooner who came pretty near being the "King of Tight Wads." He actually would save his used quids of chewing tobacco, stick them up over the galley range, and when they were dry he would put them in his pipe and smoke them. Now I don't believe in carrying economy quite that far, but I do know of several chief engineers who are using the lumpy parts of the ashes from the ash pits over again, and get considerable heat out of them, and that's no joke, either. If you don't believe it, just try it the next time you are tied up at the wharf and don't have to force your fires much. There are a good many unconsumed pieces of coal which sneak through your grate bars, in spite of all precautions, and it's these shirkers that you make use of by "zweibaching" (if I dare use that German term) the ashes.

There are also some economies that can be made in the use of steam, when the vessel is tied up. Of course, you have to run a dynamo to keep the ship lighted, and no matter whether there are many people on board or not, in cold weather you have to keep the ship thoroughly heated throughout. If you didn't, there would be a bill for "busted" pipes, which would freeze up during cold spells.

A friend of mine got up a very ingenious method of avoiding the running of the air and circulating pumps while in port. These require attention and oil, besides being heavy steam users. Then, too, he had to run his flushing pump for the sanitary system. By making a short connection between the auxiliary exhaust pipe to the steam pipe leading to the steam heating system, he shunted all of the exhaust steam from the dynamo engine and the flushing pump into the steam heating system, thereby side-stepping the use of the main condenser and the necessary pumps in connection with it.

At first blush you might think that the back pressure in the dynamo engine and the flushing pump would cause these auxiliaries to use more steam than would be saved by avoiding the use of the air and circulating pumps, but, as a matter of fact, after careful trial, he found that he saved some coal by adopting this method. The increased steam consumption, on account of the back pressure, was more than offset by the live steam he would have used in the air and circulating pumps and in the steam heating system. Of course the drains from the heating system put hot water into the feed tank to be pumped back into the boiler, thereby saving some of the wandering heat units which have but one object in life, and that is to escape. By this method he made the radiators act as an air condenser for the exhaust steam, at the same time they were heating up the quarters on the ship.

On some ships lying at the wharf I have noticed a steady stream of exhaust steam coming out of the escape pipe. Chief engineers who let steam escape that way ought to be "pinched" for robbing the coal mines, as it is a sinful waste of fuel. If you had gone aboard any of these ships, you would, undoubtedly, have found that they were using live steam from the boilers for heating the ship.

Some scientific gents have figured it out that there is only enough coal in sight to last the world at large about one hundred and fifty years. While many of us are not much worried about what will happen to marine engineers when the coal does give out at that time, we are occasionally jolted by the bills presented by the fellows who are digging out the coal these present days.

Yours for economy,

Old Scotch

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT*

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Depth at Which Submarines Operate

Q.—How far below the surface can a submarine operate and still see above the surface? B. C.

A.—Periscopes are usually 15 feet to 17 feet in length, and this is the limit to which a submarine can submerge and operate by sight.

Quality of Soft Coal

Q.—Is there any way of readily telling whether soft coal is good coal or bad coal when it is delivered on board ship? CHIEF.

A.—None, so far as I know. In general, good coal has a bright, clear luster and it should not be finely and uniformly broken up; there should be lumps in it of clear, bright coal. If coal is purchased in quuantity and continuously, it will usually pay to have a sample tested for calorific value, which can be done at small expense by many laboratories especially equipped for this work.

Chattering of Safety Valves

Q.—Can you tell me why it is that safety valves sometimes vibrate badly when blowing off steam, and in other cases where the pressure is the same do not chatter? S. V.

A.—The question of the chattering of a safety valve against its seat when discharging is, according to best information, attributed to the length of pipe between the safety valve and the boiler. This should always be the shortest possible. Where it has appreciable length it serves as a reservoir and the enclosed steam has a weight of its own and a natural period of vibration which may synchronize with the natural period of the valve spring in such a way as to cause violent chattering. The best way to stop an action of this sort is to shorten up the pipe connecting the safety valve to the boiler.

Requirements and Pay for a Position as Oiler

Q.—What are the requirements to get a place as oiler in the engine room of ocean steamers, and what is the average pay? E. M. C.

A.—Steamship companies differ as to the requirements imposed upon prospective oilers. In some companies the oilers are chosen from the fire-room force and become oilers via water-tenders. In others fire-room experience is not necessary and in many no fixed rule is in force, but the choice of oilers is left entirely to the chief engineer of the vessel. In general, a common school education, a good knowledge of the construction and operation of marine engines, and some boiler-room experience are essential and but little else. Knowledge of the operation of pumps and auxiliaries is desirable and required in many jobs. The pay is from $30 to $45 (6/5/0 to 9/7/6) a month and found in American ships, and $25 (5/4/2) per month and found in the British transatlantic service. If a young man is fairly familiar with marine engines and the engineers kindly disposed, but little experience is necessary to enable him to become a good oiler.

* Associate Professor of Naval Architecture, Massachusetts Institute of Technology, Boston, Mass.

Does Sea Ice Contain Salt?

Q.—"A" contends that after salt water ice (sea ice) has been washed with fresh water and allowed to melt, the melted water will be fresh, or in other words "A" claims that the salt is expelled from the water in the freezing. "B" claims that the salt freezes in with the water, and on melting the water will be salt. H. M. S.

A.—"A" is correct if the ice has been produced by quiet freezing, as freezing salt water excludes the salt. It is entirely possible, however, to have salt held in the ice mechanically, as when spray is blown onto a body or ice cake and freezes there. Physically it is true that ice which forms in a brine solution is composed of fresh water crystals without salt in it.

Horsepower from Indicator Cards

Q.—In computing the horsepower from indicator cards, is the horsepower of both head and crank ends added together? It would seem to me that as steam was acting on only one side of the piston at a time the horsepower of the engine would be the average of the two ends. P. MACF.

A.—The pressure on the head end acts on the down stroke and the pressure on the crank end acts on the up stroke, so that there are two impulses on the piston rod, a pull and push for each revolution of the crank; therefore, if we wish the *total* work per revolution it is the *sum* of these pressures multiplied by the distance moved through. Work done per minute ÷ 33,000 = horsepower.

Power Calculations

Q.—Will you please figure for me the indicated horsepower necessary to drive the following ship 16½ knots and the diameter and pitch of a suitable propeller for it? Unless it takes up too much of your valuable column, I should appreciate it if the calculations might be given in detail. The vessel is 425 feet between perpendiculars, 54 feet 8 inches beam and 22 feet 6 inches draft, displacement 9,380 tons, twin-screw, and the engines not to exceed 90 revolutions per minute. R. C.

A.—The power calculation is the one to make first and the effective horsepower which is used in overcoming the resistance of the hull is the frictional horsepower plus the wave-making horsepower. The first may be calculated approximately from the following formula, if the dimensions of the vessel are known:

$$\text{Frictional horsepower} = .0307\ S\ V^{2.83} \text{ where } \left\{ \begin{array}{l} S \text{ is the wetted surface, } V \text{ is the} \\ \text{speed in knots, and a coefficient} \\ \text{of friction of .01 is assumed.} \end{array} \right.$$

From Taylor's formula:

$$S = 15.5\ \sqrt{D \times L},$$

where D = displacement in tons.
L = length in feet.

$$S = 15.5\ \sqrt{9380 \times 425}.$$
$$S = 31{,}000 \text{ square feet.}$$

$$\text{Friction horsepower} = .0307 \times 31{,}000 \times 27.89 = 2{,}640.$$

The wave-making or residuary horsepower cannot be figured from any formula. The residuary resistance per ton of displacement as determined from model experiments is given in a series of curves ("Speed and Power

of Ships," by D. W. Taylor) and for the form given this is very nearly 3 pounds; therefore, the wave-making horsepower = $.00307 \times 3 \times 9{,}380 \times 16.5 = 1{,}425$ horsepower. The total effective horsepower is then the sum of the frictional and wave-making horsepowers, or $2{,}640 + 1{,}425 = 4{,}065$. In general the ratio of effective horsepower to indicated horsepower is as 1 is to 2, so that indicated horsepower = $4{,}065 \times 2 = 8{,}130$. This, then, is the indicated horsepower necessary to propel the hull given at a speed of 16½ knots.

The determination of a propeller for this case in accordance with the method indicated in "Propellers," by C. H. Peabody, gives a three-bladed propeller 16 feet diameter, 22 feet pitch and 70 percent efficiency at 88 revolutions per minute. The individual steps in the propeller calculation consist of determining the value of a function containing the known properties as horsepower, speed and revolutions per minute, and from tables which have been compiled from experimental information the diameter and pitch in consonance with these is found. The actual numerical work for this case would be unintelligible without the tables and context.

Relative Advantages of Turbines, Diesel Engine and Reciprocating Steam Engine Drive

Q.—What are the relative advantages of the turbine and Diesel engines over the reciprocating engine for ship propulsion in regard to first cost, steam consumption, service, and useful life? A. T. S.

A.—The question is too broad to be properly answered here, as it involves the consideration of so many factors as to make a comprehensive answer far too voluminous. Briefly, however, conservative engineering judgment, backed by experience in actual installations, seems to warrant the following generalizations. Direct connected turbines show excellent economy and are reliable for high-speed vessels and for these installations result in a saving of weight and space for propelling machinery. They are higher in first cost than a reciprocating steam engine installation.

For vessels of 15 knots or under, the principal turbine companies now recommend geared turbines, and even for high-speed vessels this is finding much favor. Confining attention to vessels of the cargo-carrying class at speeds below 15 knots, the margin between the several methods of propulsion is so small that local or economic conditions which may have no bearing upon engineering features often are the deciding factors.

A careful comparison of two vessels of identical external characteristics, but with a reciprocating steam engine and Diesel engines for the propelling machinery recently appeared and gives an excellent account of several items in coming to a reasonable decision.* A table is appended giving this comparison and the comparison is extended in the same manner to include approximate figures for geared turbines. Allowance has been made for the difference in tonnage measurement and deadweight carrying capacity which the systems involve. The vessel chosen for the comparison is 400 feet length between perpendiculars, 52 feet beam, 29 feet 9 inches depth, 26 feet 1 inch draft. Total deadweight carrying capacity in tons, 8,640 (steam), 8,775 (Diesel), 8,805 (geared turbines). Speed, 10½ knots; radius of action, 3,500 miles; fuel consumption, 1.6 pounds per indicated horsepower per hour; 1.6 pounds per indicated horsepower per hour (reciprocating); 1.2 pounds per indicated horsepower per hour (turbine); .61 pound per indicated horsepower per hour (Diesel).

* "The Relative Possibilities of the Diesel Oil Engine, Geared Turbine and Suction Gas Engine." North East Coast Institution of Engineers and Shipbuilders, 1912.

CAPITAL INVESTED	Oil Engine		Steam Engine		Geared Turbine	
	$381,000		$308,000		$351,000	
	Per Voyage	Per Month	Per Voyage	Per Month	Per Voyage	Per Month
Insurance	......	$2,390	......	$1,800	......	$2,050
Fuel (oil at $9.77, coal at $3.65)	$1,756	......	$2,170	......	$1,738	......
Wages and provisions	......	1,700	......	2,000	......	1,950
Wear and tear	......	537	......	488	......	439
Deck and engine-room stores	......	537	......	488	......	488
Port charges, at $1.22 per ton	3,680	......	3,590	......	3,590	......
	$5,436	$5,164	$5,760	$4,776	$5,328	$4,927
16 voyages....	87,000	......	92,200	......	85,300	......
12 months.....	62,000	......	57,300	......	59,200	......
	$149,000	......	$149,500	......	$144,500	......
5% depreciation	19,000	......	15,400	......	17,550	......
Management ..	2,440	......	2,440	......	2,440	......
	$170,440	......	$167,340	......	$164,490	......
Freight-earning cargo carried, tons	16 × 8,530	= 136,480	16 × 7,880	= 126,080	16 × 7,910	= 126,560
	$\frac{170{,}440.00}{136{,}480.00} =$ $1.25 per ton		$\frac{167{,}340.00}{126{,}080.00} =$ $1.33 per ton		$\frac{164{,}490.00}{126{,}560.00} =$ $1.30 per ton	

In general, for moderate speed ships which would be driven by a single reciprocating engine, a Diesel engine ship is more costly, as the machinery is more expensive and the hull also, on account of the twin screws, oiltight work, etc., but the space occupied by propelling machinery is less and the weight is less, so that there is a gain in cargo-carrying capacity and weight. At the present state of development Diesel engines are not suitable for high-powered vessels from engineering rather than economic reasons.

Geared turbines undoubtedly operate on increased steam economy, but there is little difference in the machinery weight and space and the first cost is higher than the standard machinery. A gain claimed for them is the absence of racing during heavy weather, which, however, is always less noticeable in any form of twin screw drive. The item of first cost is so important that it oftentimes settles the question out of hand, as it persists in the shape of increased insurance, etc., throughout the life of the vessel, and may transform receipts from profit to loss.

There is but little to choose as to reliability between the various systems, and figures are not available as to length of useful life. It is probably questionable, however, if either Diesel engines or geared turbines will have as long a period of usefulness as the present standard steam engine of the reciprocating type.

It is interesting to note that if the price of oil for the Diesel engine rises above that indicated in the table, or the price of coal falls below the given price, the margin quoted is seriously affected and may be reversed.

LAUNCH OF ONTARIO NO. 2.—The car ferry *Ontario No. 2*, said to be the largest vessel of the kind ever built on the Great Lakes, was launched recently from the yards of the Polson Iron Works, Toronto, Ont. The dimensions of the vessel are: Length, 318 feet; beam, 34 feet; depth of hull, 20 feet 6 inches; tonnage, 5,400; horsepower, 4,500; capacity, 60 loaded railway cars and 1,000 passengers; launching weight, 2,100 tons. The vessel will have accommodations on the upper deck for 800 first class passengers, while the lower deck will be used for the railway cars and the second class passengers. The cost of the vessel is about $500,000 (£102,500), and it will run between Cobourg, Ont., and Charlotte, N. Y., the port for Rochester.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries — Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Shipbuilding in Navy Yards

The remarks published in recent numbers of INTERNATIONAL MARINE ENGINEERING, both in the editorials and in the letters from marine engineers, relating to the policy and wisdom of constructing naval vessels at navy yards, have been of great interest to me. This is a policy the soundness of which is most certainly open to question and to doubt. The doubts as to the advisability of constructing battleships and destroyers in navy yards are not in the minds of civilians alone; on the contrary, they are in the minds of a very large number of naval officers. I do not have any intention of criticising either the policy of the Navy Department in building ships at navy yards or the remarks that have appeared in your paper; nevertheless, I desire to set forth a few of the facts as they appear to me.

I think that naval officers in general concede that permanent employment must be furnished at navy yards if a highly skilled and hard-working class of workmen is to be retained. In order to furnish this permanent employment, there must always be enough work on hand to keep the workmen employed for the full eight-hour day, six days in the week (except in the summer, when Saturday afternoon is given as a holiday). Now the general character of naval repair work and overhauling is not such as to offer this steady employment; in fact, it is more or less intermittent. Even under the best of conditions and with the greatest of foresight, there will be a great deal of work on hand at one time and a complete absence of it at other times. Military considerations do not allow this work to be spread out so as to make a good general average; it must be rushed to completion as soon as possible so that the ship under repair may rejoin the fleet and become a real unit for battle, rather than a paper one. A long stay at a navy yard is nearly always accompanied by a more or less complete demoralization of the crew, in the sense of a smooth working and efficient whole, so nearly all captains are exceedingly anxious to stay at a navy yard as short a time as possible.

The question then appears to be how to find steady employment for a body of skilled workmen that will be sufficiently large to take up and rush to rapid completion such general repairs and overhauling as the active units of the fleet may need. I believe that the only answer to this is to be found in shipbuilding.

However, this shipbuilding would be of an entirely different character than that which comes in for your editorial criticism. The character of shipbuilding necessary to fulfil the conditions given above would be of a distinctly non-military type; of a character for which there should not be any immediate need, such as fuel ships, transports, supply ships, tugs, etc.—in fact, it would not include any ships of a type which one or two years' additional time of building might render almost obsolete when commissioned.

The sole object of this shipbuilding would be to carry out the same function for the navy yard force that an air chamber does for a feed pump. It would act as a reservoir to receive the workmen during slack periods at the yard and, later, would act as a supply chamber to furnish workmen when they were in demand for other work. Of course the writer fully realizes that this would make the cost of the ship very high and would make the time of construction quite long, but these are secondary considerations for the types of vessels mentioned, especially when one considers the reasons for navy yard construction.

The writer believes that each navy yard should always have one ship of the character above mentioned under construction at all times. Such a policy would very soon give enough auxiliaries to the fleet, so that there would not be any pressing need to rush to completion those ships under construction. It would seem that such a policy would be all that the navy yards could fairly ask. The policy of building battleships and destroyers at navy yards does not fill the want mentioned above, since there is just as much haste in rushing such ships to completion as would prevail at a private yard, and for this reason men cannot be spared from such construction work to take up repairs when needed.

In regard to the quality of vessels built, I may state that, with few exceptions, I do not think that there is any appreciable difference. All navy yard built ships seem to be operating effectively and economically. The greater number of privately built ships are in the same class, but there are some few exceptions which furnish shining exceptions to any one desiring to cite them as models of extremely poor ships, commonly known in the fleet as "lame ducks." It would seem that a repetition of these vessels should be prevented by an efficient inspection force, properly backed up by the department.

From what I can learn, the comparing of "bids" from private companies and "estimates" from navy yards is not at all a fair proposition. As you have stated, if a contractor runs over his bid he loses his money, whereas if a yard runs over its estimates it simply applies for and gets more. If the Department desires to build ships at a navy yard, it is entirely proper that it should get the best estimates possible of the cost of such construction, but certainly such estimates, without financial responsibility, cannot be properly compared to the bids of regularly bonded contractors.

I cannot agree with your correspondent in that it is necessary for the government to keep ships under construction at all times "so that in case of emergency the government would not be at the mercy of private contractors, who charge all they can get in order to pay dividends, or what they consider a fair profit." It seems to me that more nearly is the reverse of this true, and that just so far as the government undertakes the building of the few fighting vessels that are authorized, the private shipbuilding companies will allow their plants to become more or less obsolete for this purpose, for without a fair prospect of business it cannot pay them to keep up their special equipment for this class of work. If this equipment is allowed to deteriorate, the govern-

ment will surely be at the mercy of private contractors in case of an emergency, because at such a time the navy yards will have all they can do to keep the battle fleet and its auxiliaries ready for action without attempting to expand their shipbuilding facilities. The private companies will then be obliged to charge what will seem to be an exorbitant price, simply because they will not be in a condition to undertake economically large naval work. It would seem that the natural competition among the large shipbuilding companies must certainly protect the government from exorbitant prices for naval work under normal conditions.

There are many ways in which the government is able to save on its cost of building which are not open to the contractor. One of these is in the manner and time of carrying out the trial trips and preliminary acceptance trials. When a vessel is built by a contractor it is required that she shall carry out certain steaming trials, shall make a certain designated speed, and shall show a certain economy of fuel and water before being delivered to the government. The carrying out of the necessary work and steaming to åccomplish these results add an item of expense which is of a very appreciable magnitude. In order to make the contractors' cost comparable to the navy yard estimate these trials should all be carried out by the government for a ship built at a navy yard, and their cost should be added to the cost of the ship. That this is not always the case is shown by the fact that at least one government-built battleship has held her steaming trials after being commissioned, and that the cost of such trials has therefore been largely charged to the cost of maintenance of the navy rather than to the cost of the vessel's construction.

The writer does not say that the government should not take advantage of the saving which is accomplished by using the ship's regular complement; or that it should not get the great advantage of instructing the men of the engineer's department in steaming at full power; or that it should not have the opportunity to collect all the necessary data for handling the ship while carrying out the ship's official trials. It would seem that this is a very laudable way of "killing two birds with one stone." However, it seems that all such things should be considered when one attempts to compare a contractor's bid with a navy yard estimate, and that the fact that the estimate is somewhat lower than the bid should not be taken to mean that the contractor is charging all he thinks he can get—usually believed to be more than he ought to get.

I trust that this letter is not too long for your consideration. A Naval Officer.

The Present Position of the Marine Distillate (Paraffin) Engine

During the past few years a great deal has been written about the development of the Diesel and semi-Diesel or hot-bulb engines, and the progress of these recent types of engines has received widespread attention. On account of the rapid-fire improvements and advances that have been made in the heavy oil engine, and also because of its application in large units, this type has rather obscured the earlier electric ignition engine in the eyes of the public.

It is largely true that the development of the gasoline (petrol) engine has been limited to comparatively small units, for the cost of operating a large unit on the lighter fuels would hardly be offset by any advantages that might be gained by the use of this type of machine. Be it said, however, that the internal combustion engine of the electric ignition type is not limited to the use of the lightest products of petroleum. In both Great Britain and America engines of this type using the heavier distillates (paraffin) have reached a high stage of development, and in America they have been successfully constructed in units of 500, or even 600 horsepower. England, though she leads America in the Diesel and hot-bulb engines, has not kept pace with her brother across the water in the development of the heavy paraffin engine. The greatest progress in this type of machine has without question been made on the Pacific Coast, where conditions, both as regards available fuel supply and field of application, have been especially advantageous.

The manufacture of light, high-speed gasoline (petrol) engines, for racing and pleasure boats, seems to have been carried on exclusively in the Eastern States of America,

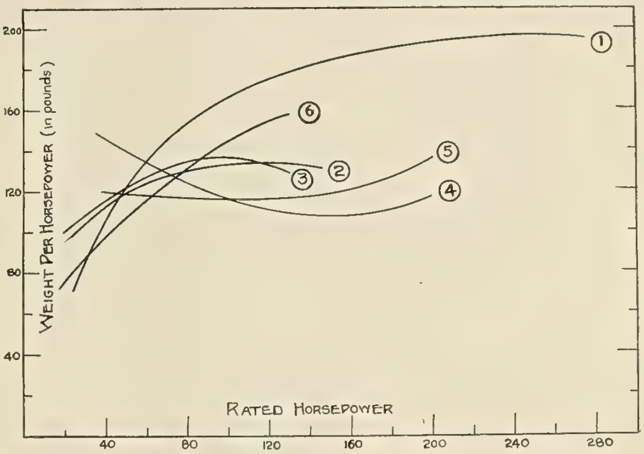


Fig. 1

while the construction of the slow-speed, heavy motor for large commercial vessels is, with a few exceptions, confined to the western coast. The reason for this is not hard to find. California is well known as one of the greatest oil-producing districts in the world, and there has consequently been an enormous supply of refined and semi-refined products available for consumption. It is only natural, then, that a simple and reliable type of engine should be developed for the utilization of these fuels.

With the construction of the first successful marine engine in San Francisco in 1884, it was recognized that the most efficient and reliable results for commercial purposes were to be obtained by heavy construction and slow rotational speeds. The service demanded by a work boat, of its propelling machinery, required an engine that would give constant service day in and day out under all conditions. A type of engine was consequently developed that closely resembles the commercial Diesel motors of the present day, as regards speed and heavy structural details.

At the present time there are half a dozen manufacturers of these heavy four-cycle distillate engines on the Pacific Coast, and from an analysis of each make of engine, it will be found that the variations in weight, speed, cylinder dimensions and general design are slight. In the following discussion three and four cylinder engines will only be considered as, of course, the one and two cylinder engines are built only in the smaller sizes.

Weight and Speed

At first sight these heavy duty engines may appear to be cumbersome, but it must be remembered, as stated above, that they are designed primarily for commercial service, where the requirements often call for full load

output day and night without a stop. Fig. 1 shows the result of plotting weights per horsepower against horsepower ratings, indicating the variation of the former quantity as the size of the engine increases. The weights given are the net weights of engines, including reverse gears. In some of the lighter types of high-speed engines the reverse gears are separate, but in the type under consideration the gear pot is mounted on an extension cast on the main engine bed, thus providing an extremely rigid unit, not unlike the modern automobile plant.

The normal epeeds of these engines are found to be comparatively low, especially in the larger sizes, thus enabling higher propeller efficiencies to be obtained and at the same time reducing the wear and tear incident to high speeds. Piston speeds vary from 550 to 650 feet per minute, while rotational speeds range from 200 to 500 revolutions per minute, depending on the size of the engine. Fig. 2 shows the variation of these quantities with respect to horsepower ratings, the curve shown representing the average of the different makes, which vary but slightly in this particular. The following average figures will perhaps give a little clearer idea of the weights and speeds of a few selected sizes, including single and double cylinder engines.

Horsepower.	No. Cylinders.	Revolutions Per Minute.	Weight, Pounds.	Weight Per Horse-power, Pounds.
5	1	400	750	150
30	2	300	4,200	140
80	3	300	9,600	120
250	4	225	50,000	200
500	8	200	90,000	180

From the above it will be seen that the units of 250 horsepower and over are exceedingly heavy machines and are only fitted for vessels of the heaviest construction. Only one manufacturer has undertaken the regular con-

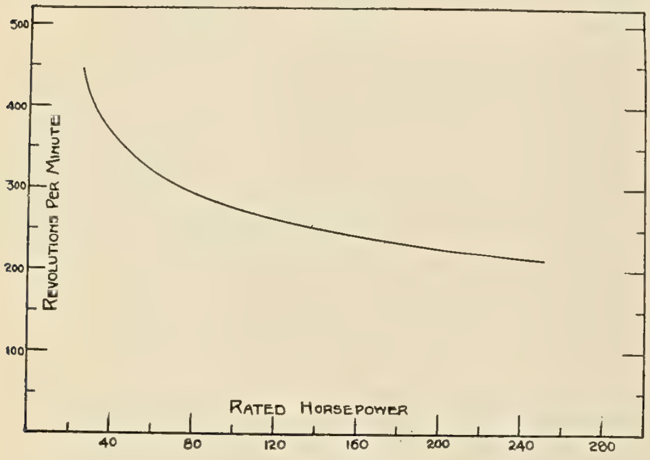


Fig. 2

struction of these heavy engines in sizes larger than 150 or 200 horsepower, but a considerable number of large installations have been made by the one concern. During the past few years fifteen installations, aggregating 4,467 horsepower, have been put into successful operation. This average of 300 horsepower per vessel is probably not exceeded by an equal number of the largest vessels propelled by hot-bulb engines.

Price

The purchaser of an engine is perhaps interested more in price than in any other item, and the curves shown in Fig. 3 should consequently prove of interest. The prices include engine, propeller, shafting, magneto, air pump, and, in fact, all that is essential for a complete installation. Discounts sufficient to approximately cover the cost of installing the engine in a boat are ordinarily given when an engine is shipped, so that the prices as given may be taken to be the cost of an installation ready to run.

The subject of price seems to be in an extremely unsettled condition and widely variant prices are often quoted on engines of apparently equal merit. However, it is most probable that the variation in price is due in part to power ratings and to features of design and construction that are incorporated in order to produce slightly

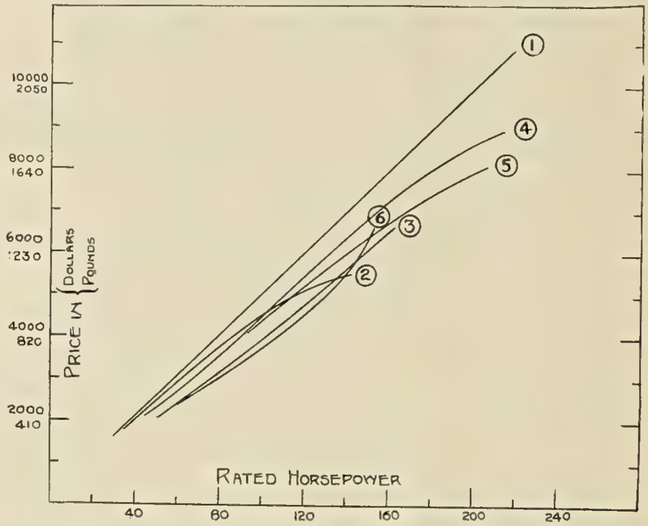


Fig. 3

more efficient results. It is nearly always a safe assumption that the more expensive machine has had more care expended in its design and construction, especially in this day of keen competition.

In conclusion it may be said that the internal combustion engine of the electric ignition type has advanced to a point where practically as much faith is placed in its continuous operation as in that of the steam engine. Units as large as 600 horsepower have been successfully constructed, and large commercial vessels equipped with engines of this type have been put into commission on long runs into the open sea under conditions where the safety of the vessel is often dependent on the uninterrupted operation of the propelling machinery. A number of specific instances might be cited of power vessels that have logged upwards of 200,000 or even 300,000 miles and that are still in daily operation.

San Francisco, Cal. Charles J. Belden.

Gas Engine Needle Valve Settings

In the operation of gas engines the effect of varying the needle valve settings upon the fuel consumption of the engine is desirable knowledge. For the information of those interested, results of a test run on an International Harvester engine, 6 inches by 10 inches, 300-350 revolutions per minute, for both alcohol and gasolene (petrol), are published.

The brake horsepower of the engine tested was maintained as nearly constant as possible in order to determine comparative results and to eliminate that variable. The radius of the brake arm was 1.7 feet, the pull maintained constant 11 pounds, and the engine constant $k = .003255$ and the brake horsepower $= .003255 \times$ revolutions per minute $\times$ pull. The specific gravity of the alcohol used was .93, and that of the gasolene (petrol) .72. The opening of the needle valve was increased from a minimum to a maximum and gave the results tabulated.

From the tables and the curves of Fig. 1 the cost of

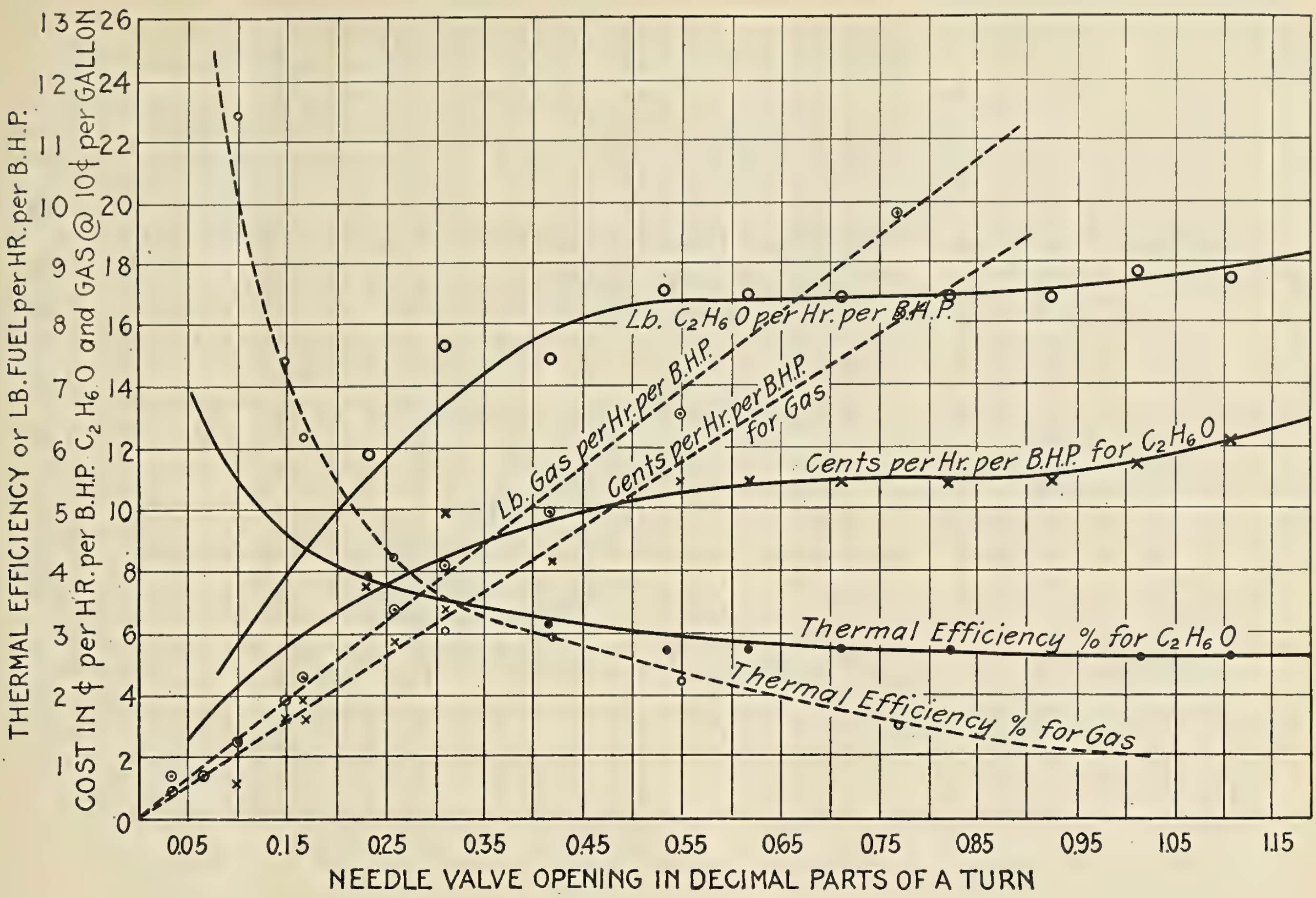


Fig. 1

TABLE A—ALCOHOL (DENATURED)

R. P. M.	Needle Valve Opening	Net Pull, Lbs.	B. H. P.	Pounds Alcohol Per Hour	Pounds Alcohol Per Hour per B. H. P.	Gallons Per Hour Per B. H. P.	Ther. Eff., Per-cent	Cost Per Hr. Per B. H. P., at 40 Cents	Cost Per Hr. per B. H. P. at 10 Cents.
328	.23	11	1.173	6.90	5.90	.76	3.92	30.4	7.6
333	.33	11	1.190	9.12	7.67	.99	3.03	39.6	9.9
338	.43	11	1.210	9.00	7.44	.96	3.13	38.4	9.6
333	.53	11	1.195	10.93	8.55	1.103	2.70	44.1	11.03
336	.63	11	1.210	10.22	8.46	1.092	2.75	43.7	10.92
338	.73	11	1.210	10.22	8.46	1.092	2.75	43.7	10.92
338	.83	11	1.210	10.22	8.46	1.092	2.75	43.7	10.92
336	.93	11	1.210	10.22	8.46	1.092	2.75	43.7	10.92
338	1.03	11	1.210	10.70	8.86	1.145	2.60	45.8	11.45
330	1.13	11	1.180	10.30	8.72	1.125	2.66	45.0	11.25
332	2.50	11	1.190	11.23	9.45	1.220	2.46	48.8	12.20
330	4.00	11	1.180	15.00	12.70	1.640	1.83	65.6	16.40

The calorific value of this alcohol was 11000.

$$\text{Therefore, the thermal efficiency} = \frac{2545}{\text{Pounds fuel per h. per B. H. P.} \times 11000}$$

TABLE B.—GASOLENE (PETROL), CALORIFIC POWER = 18000

R. P. M.	Needle Valve Opening	Net Pull, Lbs.	B. H. P.	Pounds Gas. Per Hour	Pounds Gas. Per Hr. Per B.H.P.	Gallons Per Hr. Per B. H. P.	Ther. Eff., Per-cent	Cost Per Hr. Per B. H. P. at 10 Cents
328	.03	11	1.173	.811	.693	.1155	20.5	1.155
333	.07	11	1.190	.824	.698	.1162	20.3	1.163
338	.11	11	1.210	1.470	1.245	.2075	11.4	2.075
333	.15	11	1.195	2.280	1.950	.3250	7.4	3.250
336	.18	11	1.210	2.730	2.300	.3833	6.15	3.833
338	.26	11	1.210	4.090	3.380	.5640	4.2	5.640
338	.33	11	1.210	4:920	4.070	.6780	3.5	6.780
336	.44	11	1.210	5.990	4.950	.8250	2.9	8.250
338	.54	11	1.210	7.920	6.545	1.0900	2.2	10.900
330	.77	11	1.180	11.950	9.800	1.6330	1.5	16.330

$$\text{Thermal efficiency} = \frac{2545}{\text{Pounds fuel per hr. per B. H. P.} \times 18000}$$

operation for a constant load increases rapidly for increased needle valve opening in the case of gasolene (petrol), while for alcohol it reaches its first maximum at about one-half turn and remains nearly constant until the valve is opened a full turn, after which it mounts rapidly. If denatured alcohol could be purchased for the same amount per gallon as gasolene (petrol), these curves show that it would be the cheaper fuel for loads requiring the needle valve to be opened one-half turn or more, for from that point on the consumption of alcohol per hour per brake horsepower is less than that for gasolene (petrol). Therefore it naturally follows that from the one-half turn point on, the thermal efficiency of the gas engine using alcohol is higher than when using gasolene (petrol).

As, however, the cost per gallon of denatured alcohol is greatly in excess of that of gasolene (petrol), the net cost per hour per brake horsepower is lower for the gasolene (petrol). In order to compare their relative merits regardless of cost, the curves have been plotted on an equal cost of 10 cents (5d.) per gallon.

New York. BRUCE R. WARE.

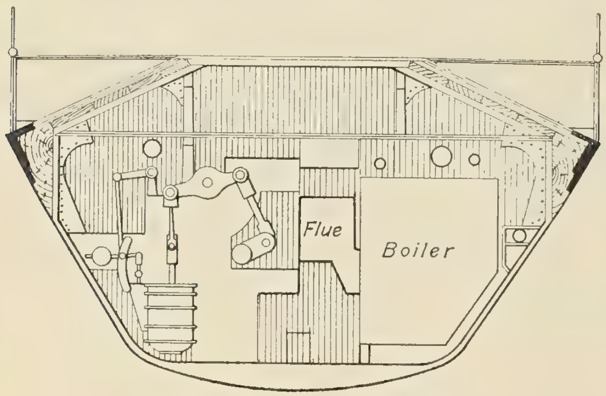
An Interesting Bit of History

The drawing which accompanies this letter is one which, I think, will interest most readers of INTERNATIONAL MARINE ENGINEERING. Probably the two most interesting vessels of fifty years ago were the Stevens *Battery* and the *Monitor*. The Stevens *Battery* was way

ahead of its time, and the drawing here shown is proof of it, as the idea of twin screws and multi-cylinder engines with short strokes and high speed is certainly modern practice.

The drawing came into my possession in the following way: The late Mr. Myers Coryel came into my office about a year before he died. He took from his pocket a tracing of the drawing here shown and told me the drawing was made by him about 1851 for E. A. Stevens, the founder of Stevens Institute. He said that the study was made and discussed by Mr. Stevens with men who were later connected with the Quintard Iron Works and the Delamater Iron Works.

Mr. Coryel was, of course, a very young man at that time, but he remembered very clearly the points under discussion, which were the necessity of keeping the engines below the waterline and the protective deck. The short connections were looked at askance and the short stroke with horror by all save Mr. Stevens, who insisted that greater economy would result on account of the higher revolutions which would allow smaller propeller



Cross-Section of Stevens Battery

wheels, which, he also insisted, would make for economy. Mr. Coryel was not sure whether it was intended to use eight cylinders on each shaft or four, but he was inclined to think it was the former. He also said that Mr. Stevens suggested that it might be possible to effect a greater economy by exhausting from the cylinders of one engine into the cylinders of the second engine, making them somewhat larger in bore. This was not favorably looked upon by the others, however.

Mr. Stevens wanted to use a boiler pressure of not less than 100 pounds, and this was pronounced impossible, unless a different type of boiler should be designed by Mr. Stevens, and this, he said, he could do by using copper tubes of small diameter and having the water inside them and the fire outside. By small tubes, Mr. Coryel said, that tubes of 2 inches to 2½ inches were meant. As far as he could remember, however, Mr. Stevens never made any working drawing for this class of boiler.

The drawing clearly shows the boiler, engine and crankshaft. Mr. Stevens gave a great deal of attention to the valve movement, and the one finally settled on for this engine was a cam shaft driven from the main shaft by means of a chain and sprocket wheels. The chain, however, was not exactly a chain but a wire cable made of copper on which were fastened balls which fitted into semi-circular depressions in the sprocket wheels.

Experiments were made with this drive, but it was found difficult to hold the balls in position. This trouble was overcome, however, by making one of the balls of composition and braising it in place and by holding the other balls in position by stringing short pieces of tubes between them and cutting out the sprocket wheels for the tubing. It is rather strange that a number of years ago experiments were made with this very same drive in Europe on Corliss engines to connect up the governor. These engines, as far as I know, were never built.

Mr. Isaac Newton undertook the design of engines for the Stevens *Battery* about 1869, and they were built by the Delamater Iron Works. The engines were built rights and lefts for the twin shafts. The cylinders were 72 inches in diameter with a 45-inch stroke. The cut-off valve was driven separately from the main valve and placed at the side of the valve chest so that the main valve could be removed without disturbing the cut-off valve.

The main valve was balanced for pressure and was also fitted with an air-balancing cylinder device. Perhaps some of the readers of this journal can tell what became of these engines when the *Battery* was broken up before completion.

General George B. McClellan was given the job to complete the *Battery* and he spent a million dollars, more or less, getting ready to do the work. Mr. Stevens had left the *Battery* and a million dollars to the State of New Jersey for its completion, but as the State could not have a navy, New Jersey gave them back to the estate of E. A. Stevens and his heirs, whereupon everybody who had any possible connection with that talented family put in claims for a part of that million and the *Battery,* so the matter got into the law and it took about eleven years, I think, for the courts to arrive at the remarkable conclusion that as the State could not own a navy it could not accept Mr. Stevens' gift; therefore, as it had never owned the million dollars and the Stevens *Battery,* it could not possibly give it back to E. A. Stevens and his heirs. It is pretty safe to say that this decision would have been rendered more promptly if the Stevens Estate had not been so large.

New London, Conn. W. D. Forbes.

Elevator Coal Barge at Mobile

The illustration shows the United States gunboat *Petrel* being coaled by the Pratt Consolidated Coal Company's elevator coal barge *Blossburg* at pier No. 1 of the Mobile & Ohio Railroad Company at Mobile. The loading capacity of this barge is 150 tons per hour, the cargo capacity of 600 tons. L. E. G.


Elevator Barge *Blossburg* Coaling U. S. S. *Petrel*

Marine Articles in the Engineering Press

Recent Investigations in Model Experiments—A New Method for Laying-Off Shell Plates—Future of Diesel Ships

Systematic Trials of Ship Models.—An account is given of the methods used at the model tank in Spezia for determining the best proportions of large, fast merchant vessels. A standard length is used, combined with different breadths varied in standard proportions. The four models tested were towed each at different drafts and displacements, thus gaining a full range of the resistance curves, from which the desirable unit can be selected. 18 diagrams. 1 table. 650 words.—*Schiffbau,* January 13.

The Ships of the United States Navy.—By Robert W. Neeser. A historical record of the ships of the United States Navy now in service and of their predecessors of the same name from 1776 to 1915. This article takes up the *Idaho, California* and *Mississippi,* giving a brief description of the vessels now under construction, which will be christened with these names and the main historical events regarding the services rendered by their predecessors. 4 illustrations. 7,500 words.—*United States Naval Institute Proceedings,* March-April.

Application, Improvement and Preservation of Wood in Shipbuilding.—The article enumerates the different classes of wood and their application to shipbuilding for keelblocks, cradles, ways, molds, staging and fenders, besides for the actual construction of wood ships. Mention is made of the short life of wood material and the means of improving and preserving it. Efficient ventilation and a good covering surface of paint or oil on thoroughly dried wood are recommended as the usual means, but special value is given to the pneumatic or pressure creosote-impregnation as the best means to extend the usefulness even of inferior woods. Pronounced economy in building cost is expected from using treated beech and fir for vessels in river, harbor and coast service. Mention is made of the comparative cost and the life of creosoted barges of yellow pine for the U. S. Engineers, built in 1900. 3 tables. 4,900 words.—*Schiffbau,* March 10.

Power-Steering Gear.—By F. Leigh Martineau. A brief historical account of the development of power-steering gear brings out the fact that the gear patented in 1866 by Macfarlane Gray is generally regarded as the father of the modern steam-steering gear, as this patent covered the separate control valve and hunting gear arranged identically as fitted in all modern gears. To A. B. Brown is accorded the premier place in the development of the steering gear, who, between the years 1867 and 1905, took out no less than twenty-six patents relating to steering gears. More than half of these patents related to hydraulic-steering gear, and a large proportion to the telemotor control. At the present time all hydraulic telemotor controls used are based on the synchronizing device covered by Mr. Brown's patent, issued in 1888. The first record of a proposal to adopt electric energy for steering vessels appeared in 1893. In recent years, however, the application of electrical gears for steering vessels has advanced in a remarkable way. The author points out that a steering gear is required (1) to move the rudder to any position with as little delay as possible; (2) to hold the rudder in this position under the stresses imposed in maneuvering the ship; (3) to give way before any abnormal stress, such as caused by a wave, and automatically to return to its former position; (4) to be absolutely reliable and (5), to be economical. Taking up each of these requirements in turn, it is pointed out that savings of as much as 6 percent of the running distance of a boat per annum can be gained by the use of the most sensitive steering gear. The conclusions are drawn by the author that the electric-hydraulic steering gear is more precise and, consequently, there is a gain in the total ship's expense due to the shorter distance traveled during the year. Further gains are made by this gear on account of reliability, as there are no parts to adjust, and the gear requires less attention than steam-steering gear. A third gain which can be made with the electric hydraulic gear is the smaller steam consumption. 5 illustrations. 4,700 words.—*Transactions of the Institute of Marine Engineers,* March.

Apparatus for Marking Shellplates.—The article describes a framelike structure for furnishing a reproduction of strake edges, seam and frame rivet centers, butts and openings of outside shellplates in such manner that the plates can be accurately marked, machined and made ready for assembly even before the frames are up. It is described as a floor on girders or channel foundation with uprights of channel section and cross connections, making 8 or 10 complete transverse square frames spaced a distance equal to the frames in the ship. Movable counterbalanced channels slide up and down, one on each frame, following by their inclinations and positions the curvature of the bottom of the ship. By short templates all strake-edges, rivet holes, etc., are transferred to these cross-channels and from them to the plate. A modification for variable frame spacing is also given. The cost of this apparatus is given approximately as $1,000 (£205). 7 illustrations. 2,400 words.—*Schiffbau,* February 15.

Twin-Screw Steamships Ciudad de Buenos Aires and Ciudad de Monte Video.—Before describing in detail the two steamers *Ciudad de Buenos Aires* and *Ciudad de Monte Video,* just completed by Messrs. Cammell, Laird & Company, Ltd., Birkenhead, for service between Buenos Aires and Monte Video, attention is directed to the remarkable progress which has been made in the design of channel steamers, of which these vessels are a type. In some respects there has been greater progress in the dssign of channel steamers than in any other branch of naval architecture. The limitations imposed in the matter of length of hull and in draft, owing to harbor dimensions, have resulted in a thorough investigation by tank experiments of the problem of resistance, so that a form of hull with special reference to the lengthening of the load line without increasing the overall dimensions of the ship has yielded favorable results. In regard to machinery also, satisfactory conditions have been worked out both in the reduction of weight per unit of power and in efficiency. In no class of ship has the advance been so rapid, from paddle-wheel engines to high-speed reciprocating machinery, later to turbines directly driving triple screws, and now to turbines actuating twin screws through gearing. It is pointed out, however, that designers have failed to make equal progress in the arrangement of quarters in such vessels, the typical channel steamers hardly offering the

most convenient arrangements for the accommodation of passengers. These new vessels, for South American owners, have a draft of only 10 feet, while the total height from the keel to the awning deck is 23 feet 3 inches, and the beam 44 feet. The length overall is 364 feet and between perpendiculars 350 feet. The G.M. is 4 feet. On the official measured mile trial the speed was 19 knots, the engines developed 5,800 shaft horsepower. The engines are of the Parsons turbine type, there being two sets of turbines each operating a propeller shaft through a gear wheel. The high-pressure turbines, which are placed inboard, made on trial a mean of 2,320 revolutions per minute, while the low-pressure turbines placed in the wings made a mean of 1,630 revolutions per minute, the propellers running at 267 revolutions per minute. The steam consumption for all purposes was about 14 pounds per shaft horsepower per hour. The thrust bearings are of the Michell type. Steam is supplied by four single-ended boilers at a pressure of 170 pounds per square inch. Either oil or coal fuel may be used. A detailed description is given of the structural arrangements, the passenger accommodations and machinery equipment. 29 illustrations. 3,300 words.—*Engineering,* December 25.

Contribution to the Question of Unsinkable Modern Ships.—The author points out that two factors should be taken into consideration for the watertight subdivision of ships: the vertical sinking after a leak and the transverse heeling or capsizing. The first has recently been considered in numerous regulations of proper bodies, the latter has not yet been touched. It was found that under certain conditions the initial stability may remain the same or increase even though certain damaged compartments are open to the sea. The factors for preserving stability of the damaged ship are discussed, to which the author adds the case of an increased or critical draft, above which stability increases. To gain a clear insight into the question the author calculated a number of examples, reduced to prismatic shape and further exemplified by models made of electrolytical copper and fitted with heeling indicator, C G adjusters and compartment flooding plugs. Thus the author feels that he is in a position to investigate the question, taking into consideration all factors, and with sufficient accuracy, so that the model experiments may serve for the building of full-sized ships. 18 diagrams. 1 table. 1 illustration. 4,400 words.—*Schiffbau,* October 28 and November 11.

The New Fruit-Carrying and Passenger Steamer Van Stirum.—Built to the order of the Atlantic Fruit Company for their new service between Central American and European ports, the steamship *Van Stirum* is the first passenger vessel turned out by the North of Ireland Shipbuilding Company, Ltd., since their Londonderry yard was put into operation a little more than two years ago. The vessel is 343 feet long overall, 45 feet beam, 20 feet ½ inch depth, molded to upper deck. The hull is subdivided by five transverse watertight bulkheads, all extending to the awning deck, and there are three complete steel decks which divide the cargo holds into compartments of suitable height for the storage of bananas, which will form the principal cargo in this service. Accommodations are provided for thirty first class passengers. A large refrigerating machine of the CO_2 duplex type, supplied by the Haslam Foundry & Engineering Company, Ltd., of Derby, is installed, which is capable of maintaining a temperature of from 50 to 55 degrees in tropical climates. Four "Sirocco" fans, direct coupled to electric motors, circulate the air through the refrigerating coolers. The air is then delivered along air trunks situated on one side of the holds and 'tween decks, from which it is distributed through the fruit compartments by means of a large series of adjustable louvres and is then drawn back to the fans through trunks on the opposite side of the vessel to repeat the same cycle of operations. The fruit spaces throughout the ship are insulated with granulated cork. The equipment of auxiliary machinery and navigating appliances is very complete. Propulsion is by a set of single-screw triple-expansion engines, with cylinders 23, 38, and 63 inches diameter by 39 inches stroke, supplied with steam by three Scotch boilers, each 15 feet 3 inches diameter by 11 feet 6 inches long, constructed for a working pressure of 180 pounds per square inch. The main engines were designed to develop about 2,400 indicated horsepower on service to give the vessel a speed of 12¾ knots; on trial, however, a speed of 14 knots was attained on the measured mile. 12 illustrations. 2,500 words.—*The Shipbuilder,* April.

Efficiency and Future of Large Diesel Ships.—The author directs attention to the fact that in comparisons between steamers and Diesel ships other factors besides thermodynamic efficiency enter. He shows that fuel oil has advanced in price within three to five years to almost three times its former figure in many harbors of Western Europe. He gives the principal other sources of special fuel oil and their characteristics. The steamer *Saltburn* and Diesel ship *Eavestone,* of equal dimensions, are technically compared, also the *Christian X* and steamer *Uckermark* commercially, the table showing the motorship the better, taking into account fuel, wages, lubrication and depreciation, but not repairs or extras. It is mentioned that often motor repairs may be sudden and severe, cylinders and covers and their parts being most affected. The advisability of using or saving some of the waste heat of the fuel is discussed. The characteristics of pneumatic, electric and steam auxiliaries are noted, and their desirability for ship work, independently driven or direct-connected to main engine. The small gain in cargo space of some of the motor ships is mentioned, also the great possibility of improvement in this direction is acknowledged. The conclusion is reached that 4- or 2-cycle engines can now be obtained of high reliability and fine efficiency, and if only fuel prices will remain within reason Diesel ships are considered to remain an important factor in oversea transportation. 4 tables. 6,100 words.—*Zeitschrift des Vereines Deutscher Ingenieure,* January 30.

Modern Gantry Cranes.—It is stated that the blast furnaces of Middle Europe have to keep very large quantities of ore and material on hand, necessitating either frequent shifts of the very large gantry over wide fields or a special distributing crane. A description of a special gantry is given, where a possible movement of 30 degrees of one leg gives an effectively increased range at small operating cost and little complication. The length of girder is 391 feet 4 inches; the capacity 10 tons. A description is also given of a crane for docks in Vienna, Austria, where barges lie a little ways off the sloping bank with two rows of sheds further up the bank. A crane was built which can unload into the sheds through roof hatches from scows or cars. The essential feature of this crane is stated to be a triangular girder, straddled by the traveling winch and thereby gaining great stability. The crane shows 130 feet between supports, is 200 feet long and 53 feet high. Full details are given of the winch, its support, the electrical equipment with brakes, the gear and contact trolleys. 40 illustrations. 5,600 words.—*Zeitschrift des Vereines Deutscher Ingenieure,* February 20 and March 6.

New Books for the Marine Engineer's Library

The Theory of Heat Engines—Stability of Floating Bodies—Harbor and Shipping Problems

THE THEORY OF HEAT ENGINES. By William Inchley. Size, 5½ by 8¾ inches. Pages, 492. Illustrations, 246. London, 1913: Longmans, Green & Co. Price, 7/6 net.

Although many excellent books exist which deal solely with one or two special branches of the subject of heat engines, there are very few which deal with the subject of the theory of heat engines as a whole. In this book the author has made an attempt to give in a complete and concise form the thermodynamical and mechanical principles of the subject, and for this reason all purely descriptive matter of actual engine designs is omitted. The book is essentially one for students, and many numerical examples are carefully worked out in the text. Examples are also given at the ends of each chapter, which the student can solve for himself.

GOOD AND BAD TRADE. By R. G. Hawtrey. Size, 5¼ by 8 inches. Pages, 279. London, 1913. Constable & Co., Ltd. Price, 6s. net.

The aim of the author in preparing this book was to examine certain elements in the modern economical organization in the world which appeared to be intimately connected with fluctuations of trade. His argument was to prove that the fluctuations are due to disturbances in the available stock of money, the term money being taken to cover every species of purchasing power available for immediate use. Briefly, the essential steps of his argument may be quoted as follows: A depression of trade occurs when the amount of credit money in existence is more than the bankers think prudent having regard to their holdings of cash and they raise the rate of interest in order to reduce the excess. An expansion of trade occurs when the amount of credit money in existence is less than the bankers think prudent having regard to their holdings of cash, and they lower the rate of interest in order to encourage borrowing. Trade depressions tend to be followed by trade expansions, and trade expansions in turn to trade depressions. If at any time trade happened to be steady, any casual disturbance tends to be magnified.

STABILITY AND EQUILIBRIUM OF FLOATING BODIES. By Bernard C. Laws. Size, 5½ by 8½ inches. Pages, 351. Illustrations, 130. New York, 1914: D. Van Nostrand Company. Price, $3.50 net.

Owing to the prominence attained by the submarine and air ship in recent years, the author has considered it advisable to set forth briefly the principles underlying the stability and equilibrium of bodies floating partially or wholly submerged in water and air, supplementing the matter which has hitherto been published on the stability of ship forms. To accomplish his purpose the author found it necessary to approach the subject in a more liberal manner, treating the bodies as subject to active as well as passive forces, and to call into requisition the principles of fluid pressure, whether liquid or gaseous, in their action upon bodies at rest and in motion. An introductory chapter gives the essential points bearing on this phase of the subject, and this is followed by a discussion of general conditions, including definitions and formulæ. Then, in turn, the subjects of ships, submarines, floating docks, air craft and caissons are taken up. Owing to the scarcity of published information regarding the stability of floating docks, the book will be of special value to shipbuilders on account of this chapter alone. The data which the author gives have been derived from a long period of intimate association with the scientific side of shipbuilding and, of course, are thoroughly reliable.

THE PROBLEM OF GREATER NEW YORK AND ITS SOLUTION. By Harry Chase Brearley. Size, 6 by 9 inches. Pages, 132. Numerous illustrations. New York, 1914: The Searchlight Book Corporation. (Under the auspices of the Committee on Industrial Advancement of the Brooklyn League.)

The problem of Greater New York discussed is the harbor problem, and it is stated that Greater New York's present welfare is dangerously threatened by its harbor limitations. In considering this problem, the author points out not only the danger of New York's commercial supremacy, but also the uneconomical effects of congestion upon living conditions. The solution of the problem is held to lie in the development of a great auxiliary harbor with an ideal industrial city adjoining it at Jamaica Bay, where some improvements have already been made, and where immense possibilities await further developments of this kind. The book is an earnest plea for the future industrial prosperity of the city that is now the greatest port in the world.

COAST EROSION AND PROTECTION. By Ernest R. Matthews. Size, 6 by 8¾ inches. Pages, 147. Plates, 33. Illustrations, 74. London, 1913: Charles Griffin & Co., Ltd. Philadelphia, 1913: J. B. Lippincott Company.

Maritime engineering is a term which has frequently been applied to an important branch of civil engineering. Its application is due to the fact that the work includes harbor engineering and coast protection. This volume, which can be classed as a contribution to maritime engineering, gives a résumé of the erosion and accretion that are taking place around the coasts of Great Britain and Ireland. It treats comprehensively of all forms of sea defenses, the merits and demerits of each type being fully discussed. Special consideration is given to methods of construction in reinforced concrete, and, what is of especial value, comparisons of costs are stated. The action of sea water on concrete is of such importance that the author has carried out numerous experiments with a view to preventing as far as possible the destruction of concrete taking place from this cause. The results which he gives in this book from these experiments will be found very useful for practical application.

SHIPS AND SHIPPING OF OLD NEW YORK is the title of a booklet that has been printed for the Bank of the Manhattan Company, 40 Wall street, New York. It contains a brief account of the interesting phases of the commerce of New York from the foundation of the city to the beginning of the Civil War. It contains a large number of reproductions of interesting and rare old pictures, together with much information regarding the days when the American merchant marine in trade all over the world was a reality. Anyone interested in the history of the American merchant marine, especially with reference to the port of New York, will find a copy of this book very readable.

ENGINEERING SPECIALTIES

The Morris Patent Double Speed Bottom-Block

For speeding up the lifting of loads on cranes and other lifting gear, Herbert Morris, Ltd., Loughborough, Leicestershire, has placed on the market a two-speed bottom chain block which provides a fast speed for the quicker handling of loads up to half the capacity of the gear, while

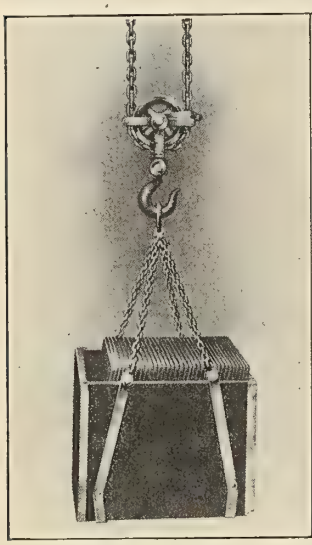


Fig. 1.—Lifting Heavy Load at Normal Speed

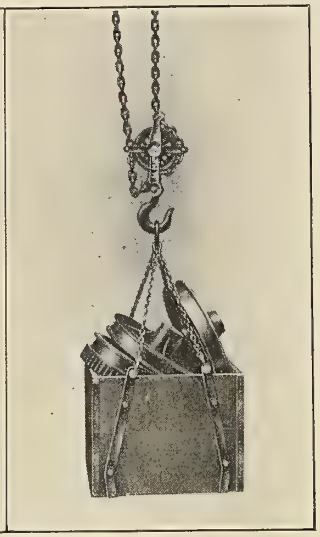
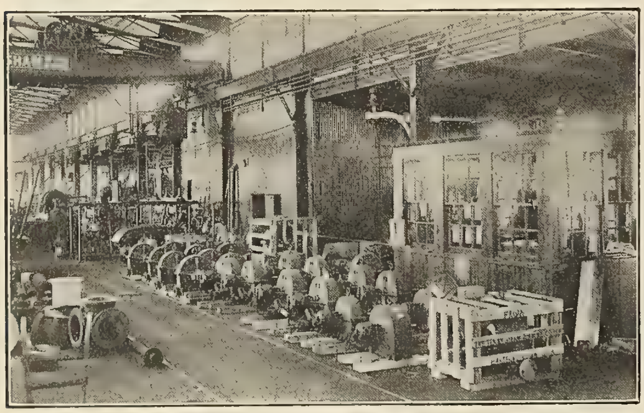


Fig. 2.—Lifting Light Load at Double Speed

heavier loads are lifted in the usual manner. From the illustrations it will be seen that the block is made with an attachment for linking on to the live side of the chain, which then takes the load up at double the normal speed. In ordinary practice it is found that most loads are under half the capacity of the gear. The block can be adapted to practically any make of crane or traveling gear lifting on a double chain.

Large Shipment of Terry Turbines

An order for twenty-three 60-horsepower Terry turbines for driving forced draft blowers in the new Christian street station of the Philadelphia Electric Company

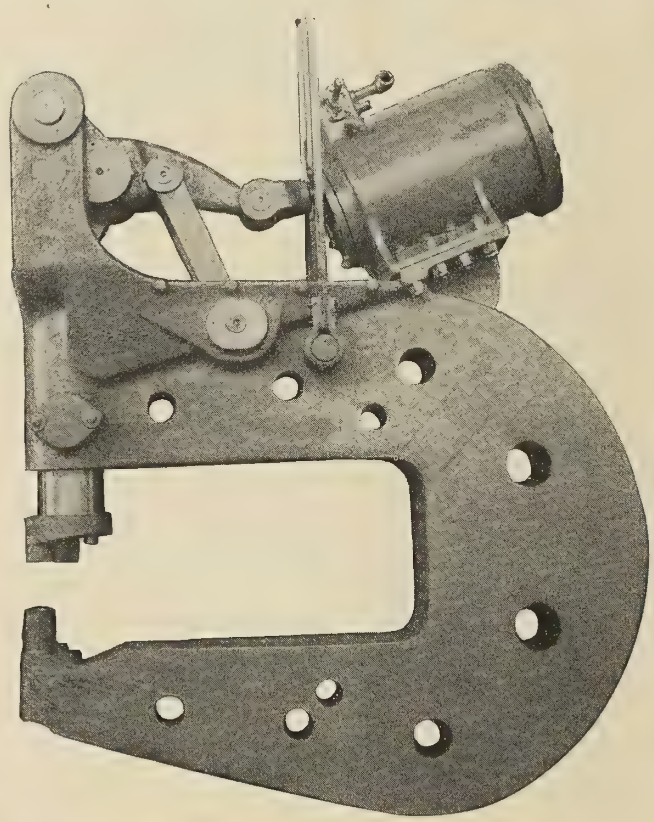


View in Terry Turbine Shops

has recently been filled by the Terry Steam Turbine Company, Hartford, Conn. Twenty of these turbines crated ready for shipment are shown in the illustration. In the background of the photograph may be seen the testing department at the Terry shops, where four vertical turbines of the type built for forced draft work on torpedo boat destroyers can be seen undergoing tests. A 100-kilowatt composite-design direct generator set can also be seen on the platform in the rear of the testing department. Power for driving the machinery in the shops of the Terry Turbine Company is derived from a 50-kilowatt turbo generator and a 20-kilowatt turbo generator located just back of the superintendent's office shown in the photograph.

One Hundred-Ton Hanna Type Pneumatic Riveter

A 100-ton, 48-inch reach, 24-inch gap pneumatic riveter, manufactured by the Hanna Engineering Works, has recently been placed on the market by the Vulcan Engineering Sales Company, Chicago, Ill. This heavy duty riveter is furnished with a cylinder having a 22-inch piston stroke with a relative travel of 6 inches of the rivet die. During



Hanna 48-Inch Reach, 24-Inch Gap Riveter

the first half of the piston travel, that is, 11 inches, which represents approximately the first 5 inches of die travel, the movement takes place through toggle action. At this point the mechanism automatically changes into a simple lever action, so that for every inch of the last 11 inches of piston travel the rivet die will move forward one-eleventh of an inch, or a total of one inch, thus producing the rated tonnage of the machine at the rivet die practically uniform for the last inch of die travel.

On account of the considerable distance through which the rated pressure is exerted, careful adjustment of the die screw is unnecessary, consequently there is no necessity for striking a rivet more than once. With each stroke of the machine, the rivet is set with a predetermined tonnage which is produced irrespective of the judgment of the operator and leaves no uncertainty as to whether or not sufficient pressure has been given to the rivet.

Owing to the fact of the slow movement of the die during the lever action, ample time is given for the metal in the rivet to flow and fill the hole completely. Also an

opportunity is given for the rivet to set before the pressure is completely released on the return stroke of the lever. This scientific distribution of power and speed, it is claimed, makes the motion particularly useful for driving cold rivets, since the motion automatically slows up during the lever action and gives the metal time to flow under full pressure, thus avoiding crystallization.

A novel feature of the machine illustrated is the flush top, which permits riveting angle connections on plate work as close up as 2 inches.

Wiegand Chain Screen Door

Everyone who has had any experience with firing a steam boiler is well aware of the inefficiency and discomfort existing whenever the fire door is thrown open either for stoking or for breaking and cleaning the fire. A solid column of cold air sweeping in at the open furnace door suddenly chills the highly heated brick work and crown sheet, causing the exposed parts of the firebox to contract on account of the immediately lowered temperature. To overcome this drawback the E. J. Codd Company, Baltimore, Md., has recently perfected and placed on the market a simple and inexpensive device, known as the Wiegand auxiliary chain door, designed to prevent the inrush of cold air into a furnace on opening the door and also to prevent the loss of heat from the furnace by radiation through the open door, consequently making the work of the firemen more endurable, as, with the furnace opening protected, he is not subjected to excessive temperatures.

The Wiegand auxiliary chain door consists of a large number of separate, freely hanging strands of small steel chain suspended from a cylinder extending across the top of the furnace door with the chains spaced as closely together as possible, thus forming a continuous sheet of chain similar to the familiar Japanese door screen. The cylinder carrying the chain screen is supported above the furnace opening in suitable brackets. When the fire door is closed this sheet of chain is rolled up on the cylinder. The act of opening the fire door automatically unrolls the chain from the cylinder and covers the furnace opening, shutting off the escape of heat and checking the entrance of cold air. The only air that can then enter the firebox must pass through the holes in the chain, which split it up into small streams, producing a better mixture with the hot gases arising from the fire bed, thereby promoting instead of hindering combustion.

An idea of the effectiveness of this device can be obtained from experiments made by placing a thermometer 10 inches in front of the furnace opening (a position usually taken by the fireman in stoking or cleaning the fire), showing that when the furnace door is open without the chain screen interposed the temperature immediately rises to about 400 degrees Fahrenheit. On covering the furnace opening with the auxiliary chain door the temperature at once falls to about 135 degrees Fahrenheit, making it possible to expose the unprotected hand anywhere in front of the screen opening without discomfort. The heat intercepted by the chains comprising the screen is returned to the furnace instead of being wasted, as any air that enters the furnace in passing through the holes in the screen takes up the heat that has been absorbed by the chains from the fire bed and carries it back into the combustion chamber.

As shown by the illustrations, this steel chain screen forms a flexible, penetrable transparent screen which does not interfere with a thorough inspection of the interior of the furnace. In fact, a better view of the fire is ob-

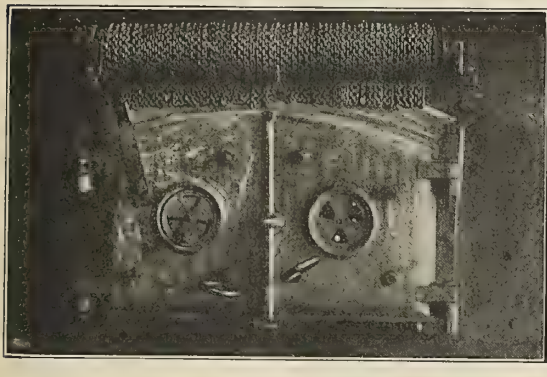


Fig. 1.—Furnace Doors Closed; Chain Screen Rolled Up

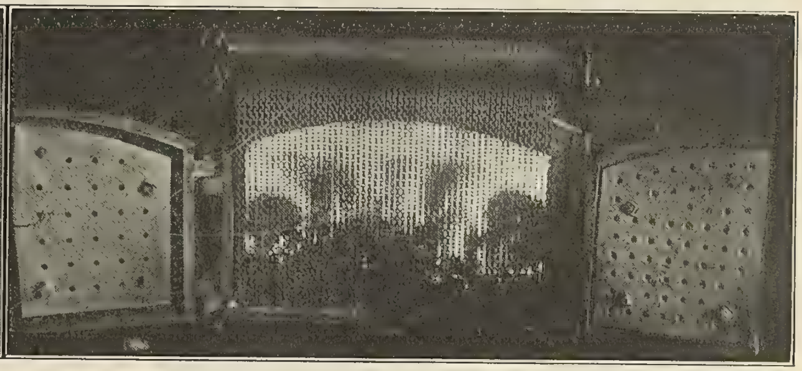


Fig. 2.—Furnace Doors Open; Chain Screen Lowered

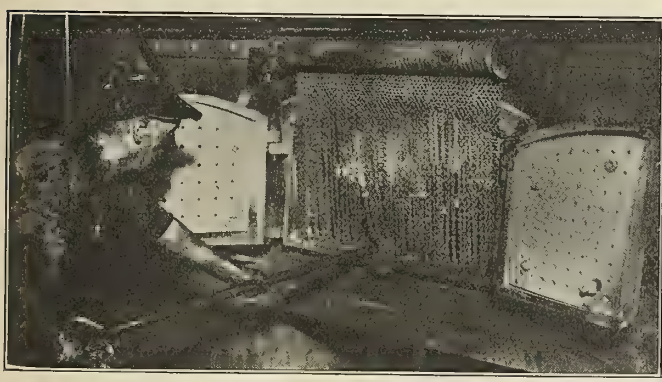


Fig. 3.—Cleaning the Fire Through the Screen

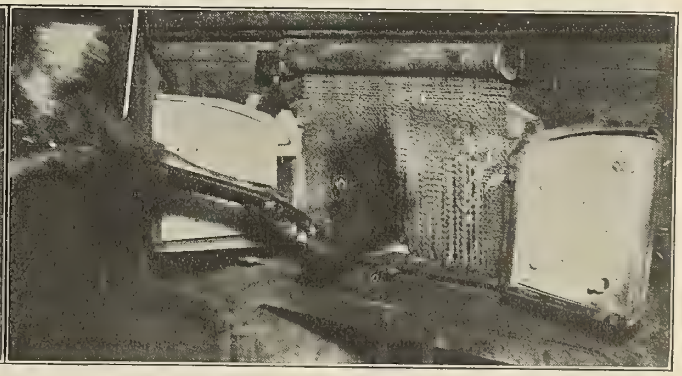


Fig. 4.—Stoking the Fire Through the Screen

tained through the links in the chain than when the entire fire bed is exposed, as the strong glare is toned down. Furthermore, the screen offers no obstruction to handling the fireman's tools, for the flexibility and lightness of the chains enable the firemen to stoke the furnace or clean the fire directly through the screen.

The Wickes Continuous Electric Blue Printing Machine

Wickes Bros., Saginaw, Mich., has placed on the market a small, compact, electric blue printing machine which will print continuous rolls or separately cut sheets of any desired length and any widths varying from 2 inches up to and including 48 inches. The blue print paper travels over a feeding belt on an incline with the tracing, and is

Wickes Blue Printing Machine

carried to a feed roller and around a printing cylinder in which is mounted the lighting element. The blue print paper is then delivered to a light-tight storage compartment and the tracing is delivered back to the operator.

The light is obtained from a mercury vapor lamp of standard pattern which is very rich in chemical light, practically all of the energy being given out in actinic rays. The lamp requires 3½ amperes at 110 volts and is automatic in operation. The total current consumption of the machine, including the lighting element and the motor at 110 volts, is only 5 amperes.

The printing cylinder which surrounds the lighting element is composed of longitudinal and spirally-disposed wires woven right-handed at one side of the center of the machine and left-handed at the other side. This, it is claimed, gives a very desirable ironing or spreading effect to each side of the tracing, and gives an absolutely perfect contact between the tracing and the paper. The spirally-disposed wires of the cylinder offer much less actual obstruction to the light than would a glass cylinder, the distance from the light to the paper being only 2 inches around its entire circumference. No ventilating fan is necessary, as the heat from the lighting element passes off rapidly through the open grill work of bronze wires.

Personal

D. J. Lamey has been appointed second engineer of the West Kentucky towboat *Egan.*

George Armshaw has shipped from New Orleans, La., as chief engineer of the steamer *Mexicana.*

Joseph Pilaski, of New Orleans, La., has been appointed second assistant engineer of the steamer *Curry.*

William Rigny, of New Orleans, La., has been appointed first assistant engineer of the steamer *Mexicana.*

Thomas Neilson, of New Orleans, La., has been appointed chief engineer of the tank steamer *Bayway.*

Joseph Blunt of New Orleans, La., has been appointed second assistant engineer of the steamer *Mexicana.*

Robert Mosely has been appointed chief engineer of the New York State tug *Schenectady* at Watervliet, N. Y.

Charles Johnson, of New Orleans, La., has been appointed second assistant engineer of the tank steamer *Bayway.*

Thomas Fielding has been employed by the Associated Bar Pilots of New Orleans, La., to take charge of their pilot boats.

William F. Brookes has been appointed chief engineer of the steamer *Mamie D.* of the Bowie Lumber Company, New Orleans, La.

Jerome Morrow, of Sturgeon Bay, N. Y., has been appointed chief engineer of dredge *No.* 51 of the Great Lakes Dredge & Dock Company at Troy, N. Y.

Henry Stammell, formerly chief engineer of the steamer *Hudson Taylor,* will have charge of the tug *James A. Morris* on dyke work at New Baltimore, N. Y.

Charles Du Bois has been appointed chief engineer of the steam tug *Charles H. Pike,* running between Whitehall and Waterford on the New York State Barge Canal.

Joseph Vick, of Paducah, Ky., formerly chief engineer of the steamer *Oscar Barrett,* has been transferred to the steamer *Barrett,* whrre he is serving as second engineer.

Arthur Hunt, formerly of the Albany Towing Company's tugs, will be chief engineer of the steamer *Hudson Taylor* of the Central Hudson Steamboat Company from Albany, N. Y.

Arthur Robinson has been appointed chief engineer of the steamer *Du Barry,* which is now running on the Mattox Creek route from Washington, D. C., under Captain Sly's command.

William G. Emmick of Paducah, Ky., has been appointed chief engineer of the river steamer *Nashville,* succeeding Joe Vandergrift. Mr. Emmick's brother is second engineer of the *Nashville.*

Charles L. Gunn, of Paducah, Ky., has been appointed chief engineer of the West Kentucky towboat *Egan,* filling the position made vacant by the resignation of Dan Varble, formerly chief engineer of this vessel.

C. J. Tenneson has been appointed chief engineer of the steamer *Angler,* which has been placed on the excursion route between Liverpool and Washington, D. C., with Captain William Davis in command.

John Murry, formerly a well-known marine engineer, died on March 2 at Soldier's Home, Jackson county, Tennessee, aged forty-seven years. Mr. Murry was a member of the crew of the steamship *Merrimac* during the Spanish-American War.

Floyd Lounsbury, formerly chief engineer of the tug *Mabel,* Albany, N. Y., will have charge of the engine room of the steamer *Empire,* running between Albany and Troy, N. Y., during the coming season. Captain Charles Picket will be in command of the *Empire.*

J. H. Clark, recently appointed assistant general superintendent of the New York division of the Baltimore & Ohio railroad, and general superintendent of the Staten Island lines, was formerly superintendent of the floating equipment of the Baltimore & Ohio Railroad. For many years Mr. Clark has been a prominent member of the National Board of Steam Navigation.

Frank S. Martin, consulting engineer and naval architect, at 52 Beaver street, New York, has made a specialty of marine refrigerator work and is now prepared to furnish plans and specifications for all classes of refrigeration for marine service for the carrying and the storage of frozen and chilled meat, fruit, etc., and also to supervise the installation of the plants or the repairing and testing of same.

E. W. Talman, until recently chief engineer of the United States dredge *San Pedro,* has retired after fifty years' service as an engineer. Mr. Talman was born in Pennsville, N. J., in 1831, and at the age of eighteen became a machinist's apprentice with Rainey & Nafie of Philadelphia. During the Civil ar he served in the Union forces, both ashore and afloat, and at the close of the war began an eventful career as a marine engineer, which led him to many parts of the world and into many strange adventures.

W. H. Pleasants, for many years vice-president and general manager of the Ocean Steamship Company of Savannah, was recently elected president of the company. Mr. Pleasants was first connected with the Florida, Central & Peninsula Railroad Company as general freight agent in 1898. In 1900 he became general freight and passenger agent of the Ocean Steamship Company. Two years later he became traffic manager of the Seaboard Air Line, but in September of that year returned to the Ocean Steamship Company, of which he is now president.

A. H. Clement, of A. H. Clement & Company, forwarding agents of New Orleans, has been elected president of The Association for the Development of American Shipping, Inc., recently organized by a group of steamship men of New Orleans and vicinity for the purpose of encouraging the enactment and enforcement of legislation favorable to the enlargement and development of the American merchant marine. The society is also empowered to participate and assist in the promotion of the organization and operation of corporations for building, acquiring, owning or operating ships under the American flag. J. W. Cory, of Gulfport, Miss., is vice-president of the society, and George F. Taylor, formerly vice-president of the Mobile Steamship Company, Mobile, Ala., is secretary and treasurer.

George T. Cahill, chief engineer of the steel tug *Marguerite* of the Great Lakes Dredge & Dock Company, engaged in work near the State dam at Troy, N. Y., went through a thrilling experience on April 15. Two large towboats operating at the dam were caught in the eddies when the tide was running about eleven miles an hour and became unmanageable. In response to their calls for help, the tug *Marguerite* was sent to their assistance, but caught on a ledge of rocks, whirling around and capsizing on her beam's end in less than a minute. The crew all climbed to the high side and had the raft ready for escape in case the boat should be swept into deep water, but fortunately no one went overboard and the entire crew was saved. As a strange coincidence it was just ten years and ten days that Mr. Cahill was shipwrecked near the same place and the captain of the vessel was drowned.

Obituary

Morgan Robertson, inventor of the periscope, the "eye" of the submarine, and widely famed as an author and poet, did suddenly March 24.

George W. Sherwood, until recently superintendent of the lighterage department of the Mallory Steamship Company, died on April 2 at his home in Brooklyn, N. Y., at the age of seventy-one.

Professor Charles William MacCord, professor emeritus of the Stevens Institute of Technology and a noted draftsman, died recently at his residence in Hoboken, N. J., in his eightieth year. Professor MacCord was born in Dutchess county, New York, and was educated at Princeton University. He became draftsman for Captain John Ericcson in 1859 and drew the plans for the famous *Monitor,* the conqueror of the famous Confederate ironclad *Merrimac.* Professor MacCord remained with Ericcson until 1868, and after several years in private practice became professor in drafting work and designing at Stevens Institute.

John Englis, of the widely-known shipbuilding firm of John Englis & Son, at Greenpoint, N. Y., died at his home in Brooklyn on April 1 at the age of eighty-two. Mr. Englis entered the shipbuilding business at the age of seventeen in the plant established by his father at the foot of East Tenth street, Manhattan. Later he was admitted to the firm, which became known as John Englis & Son. Among the famous steamers built by this firm were the *Daniel Drew, Dean Richmond, Old Colony, Saratoga, City of Troy, C. H. Northam, Columbian, Grand Republic, Tremont, Forest City, Star of the East, Katahdin, Cambridge, Falmouth, John Brooks,* and many of the famous old-time coasting steamers, such as the *City of Mexico, City of Nerida, City of Havana, City of New York, City of Atlanta* and *City of Columbia.* The last notable steamboat built in its entirety at the Englis yards was the *Adirondack.* Mr. Englis was one of the organizers of the Main Steamship Company, was long its vice-president and general manager, and for a time its president, until it was sold to the New England Navigation Company. He was formerly president and for fifty years a director of the New Jersey Steamship Company (People's Line), between New York and Albany; vice-president and managing director of the Brooklyn Ferry Company, New York; formerly president and director of the Portland Steam Packet Company, and also a director in the International Steamship Corporation. At his death Mr. Englis was still a director in the Charleston Steamship Company, the Clyde Line, the Ward Line, the Mallory Line, the Catskill Evening Line, and in other corporations.

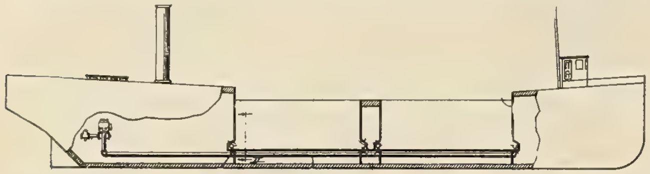
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,127,138. SAND BARGE. CHARLES C. WEST, OF MANITOWOC, WIS., ASSIGNOR TO MANITOWOC SHIP BUILDING AND DRY DOCK COMPANY, OF MANITOWOC, WIS., A CORPORATION OF WISCONSIN.

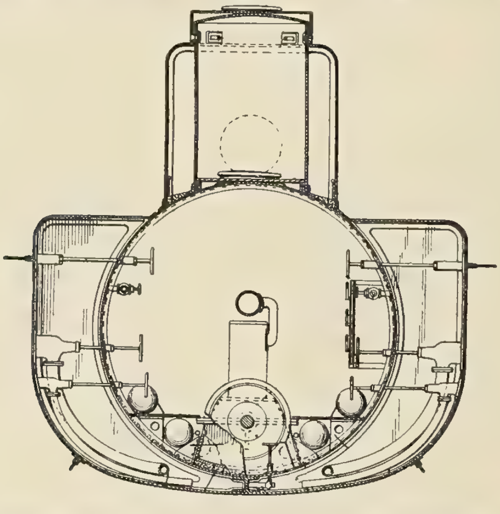
Claim 1.—A sand barge of the type wherein clam shell or similar bucket unloading devices are designed to be employed to unload the hopper contents, the combination of the sand containing hopper, a self-contained suction screening device disposed with said hopper out of the



path of travel of said unloading devices and provided with a head and an outlet opening formed in said head, and a suction creating device located adjacent said hopper and having a tubular connection leading to its suction side from the said outlet opening. Four claims.

1,127,707. SHALLOW-DRAFT SUBMARINE BOAT. FRED BROWN WHITNEY, OF WAUKEEGAN, ILL.

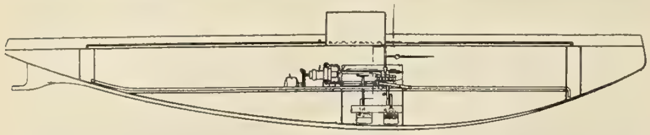
Claim 1.—A shallow-draft submarine boat, comprising an inner hull of sufficient strength to resist the pressure incident to submergence, and having a substantially cylindrical intermediate section constituting a machinery compartment and tapering end sections, and an outer hull partly surrounding said cylindrical section and spaced therefrom, the space



thus formed providing water-ballast compartments, propeller shafts journaled in the after end of said main hull having propeller wheels on their outer ends, motors having their shafts connected direct to the inner ends of said propeller shafts, dynamos located in said machinery compartment and mounted on the keel plate of said main hull, and engines also located in said compartment and on said keel-plate, each engine having its shaft connected direct to one dynamo, the shafts of said dynamos and engines being disposed in a plane substantially parallel with the longitudinal axis of the boat and below the vertical center thereof, as specified. Seven claims.

1,127,648. BALLAST-CONTROLLING APPARATUS. SIMON LAKE, OF MILFORD, CONN., ASSIGNOR TO LAKE TORPEDO BOAT COMPANY, OF MAINE, OF BRIDGEPORT, CONN., A CORPORATION OF MAINE.

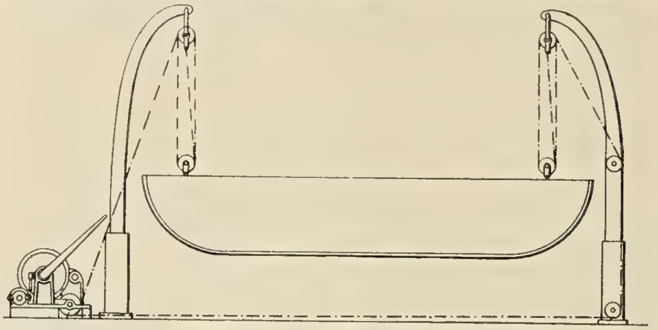
Claim 8.—The combination with a submarine boat having forward and aft trimming tanks in the bow and stern, respectively, and final adjusting tanks at the amidships section of the boat, and a valve controlled pipe



connecting said final adjusting tanks with the water of flotation, of a pump, a valve casing having a plurality of communicating passages piped to said trimming tanks and said final adjusting tanks, communicating passages piped to said pump, and a passage piped to the water of flotation, a normally open valve controlling the communication between the passages leading to the pump, and normally closed valves controlling the communications between the several passages communicating with the said tank pipes, a valve controlled vent for the said trimming tanks, a rotatable control lever pivotally mounted on said valve casing and having a horizontal member adapted for engagement with the stems of all of said valves, said lever being also adapted to operate said vent valve, substantially as and for the purpose specified. Ten claims.

1,128,656. APPARATUS FOR HANDLING LIFE-BOATS. HARRY W. BROADY, OF BAYSIDE, N. Y., ASSIGNOR TO WELIN MARINE EQUIPMENT COMPANY, A CORPORATION OF NEW YORK.

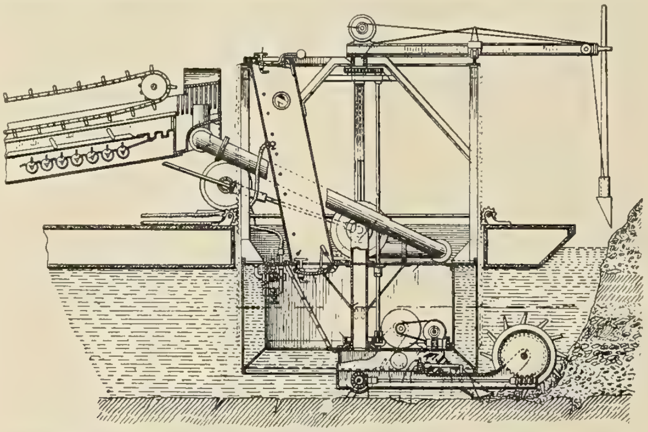
Claim 1.—Apparatus for handling lifeboats embodying therein a pair of davits, falls connected to each end of the lifeboat and to the davits, a pair of drums mounted on the vessel, one of such drums having the running part of the falls connected to ene end of the lifeboat wound thereon, and the other having the running part of the falls connected to



the other end of the lifeboat wound thereon, common means for driving and braking said drums, and interchangeable means connected to the running falls for hoisting and lowering the boat or for adjusting the lengths of the falls at opposite ends of the boat. Seven claims.

1,129,351. DREDGING APPARATUS. SIMON LAKE, OF MILFORD, CONN.

Claim 1.—In a dredging apparatus, the combination with a float and a vertically movable submergible chamber arranged in said float and open at its bottom, of a suction apparatus having a pipe extending into and toward the bottom of said chamber, a casing forming the intake of the



suction apparatus and having a swivel connection with the lower end of said pipe, means arranged within the casing and movable with it for separating and collecting the valuable material, means to move said casing horizontally, a movable intake pipe applied to said casing, and means arranged in advance of said intake pipe to loosen the material to be dredged. Six claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

10,737/1914. MARINE ENGINE GOVERNOR. G. McCLURE, 47 ST. VINCENT CRESCENT, GLASGOW, SCOTLAND.

Claim.—The governor consists essentially of two parts, namely, a steam cylinder which acts directly by means of a piston, rod and lever on the throttle valve, or an electrical arrangement of magnets or electro motors may be employed to control the valve, a water box in which a diaphragm operating the steam valve of the steam cylinder is fitted, which diaphragm is in direct connection with the sea on both sides, the under side with the inlet at the forward end and the upper side with the inlet at the after end of the ship any movement of the diaphragm is due to the difference of pressure at these parts. By utilising the pressure due to the hydraulic head of the wave approaching the stem of the ship, the throttle valve is closed in sufficient time to anticipate the racing which would occur when the above wave passes the center of buoyancy and raises the stern and the propeller partly out of the water.

14,191/1913. IMPROVED EQUIPMENT FOR NAVIGATIONAL PURPOSES. KELVIN & JAMES WHITE, LTD., AND ANOTHER, GLASGOW, SCOTLAND.

This invention has for its primary object to increase the utility of the mariner's compass when used in conjunction with the azimuth mirror, and of a telemeter, for determining the position occupied by a ship in relation to a landmark, and also, if desired, the extent in degrees by which the ship's course must be varied so that the ship may pass a landmark abeam at a desired distance. The determination of the position of the ship in relation to a landmark involves the measurement by means of the "log," of the distance traveled by the ship between two stations, or positions at which bearings of the object in relation to the ship's course have been taken, and a simple mental calculation, the factors of which are furnished by the log and by a cotangent scale applied to the compass, the characteristic feature of which scale is that the numerical value assigned to each marking is proportional to the cotangent of the angular displacement of the particular marking from the lubber line of the compass.

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Lake Traffic Monopoly Ended

Important results are expected by shipping interests from the recent decision of the Interstate Commerce Commission, which separates the steamship lines on the Great Lakes from the railroads which have hitherto owned and operated them. The decision goes into effect on December 1, 1915, and is based on the Panama Canal Act forbidding railroad ownership of competing water lines except where it can be shown that public convenience and necessity are served by such control. The lines which are directly affected by this decision have been the means of stifling competition in waterborne traffic on the Great Lakes through rate schedules devised by the railroad companies that have controlled the steamship lines. A monopoly of lake transportation has thus been created and traffic between the lake lines and the canal barge lines operating on the Erie Canal has practically ceased, to the injury of both carriers. With independent steamship lines on the Great Lakes, free to operate in conjunction with the canal barge lines, a through water route will be furnished from the western lake ports to the eastern seaboard, and it is anticipated that this arrangement will prove advantageous to the interests of both carriers. If these expectations are realized, not only will the value of the Erie Canal be enhanced but the usefulness of the new State Barge Canal when completed will be insured and a large volume of traffic will be diverted to this important thoroughfare.

The Shipbuilding Boom in the United States

Owing to the present war conditions, prices of steel used for shipbuilding in Europe have reached a point very materially higher than that for which steel is sold for shipbuilding in the United States. When to this increased cost of material is added the large increase in wages that now prevails in British and continental shipyards, the cost of building ships abroad will be found to be higher than it is in the United States. Furthermore, practically all of the British and continental shipyards are occupied very largely, if not wholly, with naval work, so that very few orders are being placed with them for new merchant vessels. With the existing tonnage in Europe decreasing at an abnormal rate it is only natural that shipowners in Great Britain, Spain, Portugal, Germany, France, Russia, Denmark, China and other countries are inquiring as to the possibilities of having vessels built in the United States, especially as the demand for tonnage for handling the increase of ocean traffic after the war is over will be urgent. In the meantime, nearly every steamship company flying the American flag is looking for new vessels. Among these are the Ward Line, the Union Sulphur Company, the Gulf Refining Company, the Luckenbach Steamship Company and the Clyde Line, all of New York, the Matson Navigation Company of San Francisco, the Merchants' & Miners' Transportation Company of Baltimore, and other companies. As a matter of fact, at the present time there are few American shipyards that can contract for the delivery of a ship of any size inside of twenty to twenty-four months. With all the business in hand and in sight, the majority of American shipyards have all the work that they can possibly handle for at least five years to come.

Growing Importance of the American Merchant Marine

According to figures supplied by the Department of Commerce, from July 1, 1914, to May 1, 1915, there were 877 merchant vessels of 179,450 gross tons built and officially numbered in the United States. These, added to 142 foreign-built vessels of 500,705 gross tons admitted to American registry under the Act of August 18, 1914, give a total increase in the American merchant marine of 1,019 vessels of 680,155 gross tons for the past ten months, which is considerably larger than the increase of any previous year. During the fiscal year ended June 30, 1907, the new tonnage added to American registry was 596,708 gross tons, and until that year the record was held by the fiscal year of 1855, with 586,102 gross tons. Considering the fact that the American merchant marine is the third largest in the world, its present rate of increase is very encouraging to shipowners and shipbuilders. Especially is this so as heretofore American ships were confined almost wholly to domestic trade, whereas now they are beginning to share to a limited extent in the overseas trade, with the likelihood that as the importance of this factor to the permanent welfare of the country becomes more fully recognized the public at large will be led to foster the shipping and shipbuilding

industries, rather than to hinder and restrict them as in the past. With better prospects at hand for the shipbuilding industry, there will also result a very great economic advantage for American shipyards, for the reason that steady employment, with opportunities for advancement, can be offered to their employees, thereby giving the opportunity to perfect shipyard organizations to a state of efficiency in economy and excellence of production that hitherto has been impossible on account of the lack of steady employment and advancement for the men who have been trained in this special work.

Dredges and Dredging Operations

The proper selection of a dredge for any particular service depends upon a great many factors, and, as the physical characteristics of various harbors and waterways differ widely, no standard dredging equipment can be said to apply to every class of work. In Europe the prevailing types of dredges commonly used for harbor and reclamation work are the bucket ladder and the suction hopper dredges. In America the dipper dredge, the hydraulic dredge and the seagoing suction dredge are the prevailing types, although various modifications of these and other types are extensively employed. The dipper dredge, however, can be called a distinctively American invention, or, rather, adaptation, as it is merely the logical development of the early makeshift apparatus formerly used by contractors who were accustomed to land excavations and were generally unfamiliar with marine requirements and construction. In recent years, however, the dipper dredges built in the United States are highly developed machines of large capacity, operated by powerful machinery and capable of meeting the severest conditions.

The bucket ladder type of dredge, which had its inception many years ago in England, has also been developed in large capacities, and has the advantage that it can be built in the form of a seagoing vessel of hopper construction, so that it can cut its own flotation and then carry the dredged material to a suitable place for its disposal. Although bucket ladder dredgers have been built to operate at depths of 50 feet below the level of the water, they are apparently not so well adapted to working in confined spaces, and it is impossible to handle large-sized boulders. The number of working parts in this type of dredge is large as compared with other types, and, for this reason, there is a tendency toward excessive cost of maintenance.

A type in which there is a less number of wearing parts, and which is specially suitable for handling softer material, is the seagoing suction hopper dredger, where the material to be dredged is drawn through a suction pipe by a centrifugal suction pump and discharged either into the dredger's own hoppers, or overboard into barges alongside, or through a long line of pipe to a place suitable for its disposal. With the ordinary hydraulic suction dredge, the percentage of solid material delivered to the hopper frequently amounts to only 15 to 20 percent of the discharge from the pump, although in certain specially constructed types of suction dredgers it is claimed that anywhere from 50 to 90 percent of solid material is delivered with the discharge.

Many improvements have been made in recent years in standardizing the design of hulls for dredgers, particularly in the seagoing suction type where the hull is similar to that of an ordinary steamship. In the dipper or inland hydraulic dredge, however, the design of the hull is usually open to improvement. It is necessarily of shallow draft, and the beam is limited, leaving the length as practically the only variable dimension. Provision must be made for supporting the heavy weights of machinery and for resisting the racking strains set up in the hull by the operation of the dredge. A box-like structure of bridge, or structural, construction is hardly suitable for such purposes and the design of such a hull should be carefully worked out by experienced naval architects, so that the necessary longitudinal and transverse strength will be provided for the excessive strains to which the hull is subjected.

The size to which various types of dredgers have been developed and their capacity can be seen from the descriptive articles published from time to time in this journal. One of the largest seagoing suction dredgers in existence is the *Leviathan*, built by Cammell, Laird & Company for the Mersey Dock & Harbor Board. This vessel is about 500 feet long, with a speed of 10 knots, and is capable of raising 10,000 tons of material from a depth of 70 feet below the waterline in fifty minutes. Another large seagoing suction dredge is the *New Orleans*, built by the Fore River Shipbuilding Corporation for service at the mouth of the Mississippi River. The *New Orleans* is over 300 feet long with a capacity of about 3,000 tons, and has handled material at the rate of about 1,500 cubic yards per hour. The seagoing suction dredges in New York harbor have a capacity for handling nearly 1,000 cubic yards per hour. A number of large suction hopper dredges have been sent out to India from English builders, one from Wm. Simons & Co., Ltd., for the Calcutta Port Commission, having a capacity of raising 5,000 tons of sand per hour. Two other reclamation dredgers, delivered by the same builders for the Bombay Trust, have handled as much as 2,700 cubic yards of material per hour, which is 35 percent in excess of the designed capacity.

The cost of dredging with a modern suction cutter dredge varies, of course, with the conditions under which the dredge is operated. In harbor work a hydraulic dredge of the most modern type has handled material at the rate of 574.9 cubic yards per hour at a cost of only 3.24 cents per cubic yard. On Lake Michigan, working in heavy clay in the open lake, subject to damage and detention of weather, a hydraulic dredge has excavated hard clay at a cost of less than 10 cents per yard, the cost including incidental expenses, repairs, supplies, insurance, etc., but not interest or depreciation.

The volume of tonnage represented by dredge construction each year is probably insignificant as compared with

other classes of shipbuilding, but at the same time the importance of dredging operations to navigation is by no means insignificant. The sums of money spent each year in the improvement of harbors and rivers are continually increasing to meet the demands of the rapidly growing maritime commerce of the world and to make existing harbors of sufficient depth to accommodate the largest ocean liners. With the pressing need for deeper and more commodious harbors it is of the greatest importance that the actual harbor and waterway improvement operations should be carried out in the most economical manner, and for this reason dredge building has been developed into an important specialized branch of shipbuilding.

Electric Propulsion

That the field for the application of electricity afloat is by no means limited to auxiliary power purposes is clearly shown by recent practice in the United States navy and by experiments with a view of demonstrating the possibilities of extending the use of electricity to a number of novel applications in commercial work.

The most conspicuous project that is now being carried out is, of course, the installation of electric drive on the 30,000-ton battleship *California*. In this case the power for propelling the vessel is to be developed by two 18,000 horsepower, turbo-generating sets operating at 2,200 revolutions per minute. The power thus developed will be delivered to the propeller shafts by four 7,500 horsepower induction motors. At the full speed of 22 knots the power required is estimated at 36,000 horsepower, while at 14 knots only about 7,000 horsepower will be required. Due to the high efficiency of the electrical speed adjustment system employed it is claimed that the steam consumption per horsepower-hour will be approximately the same at both speeds. Seventy-five percent of the power generated theoretically by the ship's turbines will be delivered to the generators, and it is estimated that there will be a loss of only 8 percent in the electrical equipment. In addition to the electric power for propulsion, all of the engine room auxiliaries will be electrically driven by direct current taken from the small, non-condensing turbo-generators that supply excitation for the main generators. It is said that the use of electric drive on the *California* represents a saving of about $200,000 (£41,000) in the first cost of the propelling machinery, and that it offers superior economy in operation, besides reducing the weight of the propelling machinery and providing full power for reversing without the addition of astern turbines as is the case in direct turbine drive. Simplicity and reliability of operation have already been demonstrated with the smaller installation on the collier *Jupiter*, and there is good reason to believe that the larger installation on the *California* will demonstrate more conclusively the special advantages which this form of drive possesses for ships where the service is so varied and severe as on a battleship.

In addition to naval work, however, the possibilities of electric propulsion have attracted the attention of engineers engaged in commercial work and a number of novel proposals have been made as to its application in this field. In the paper by Mr. William T. Donnelly, which is concluded in this issue, is described a very complete installation of electric drive as made on a small boat for experimental purposes. This installation has many distinctive features which should be of great value in the scientific investigation of problems relating to ship propulsion. Some of the problems which it is proposed to attack include the efficiency of propellers under varying conditions of power and speed, the resistance of hulls while under the action of propellers, the influence of shallow water and confined waterways upon the resistance of hulls and many other problems of the greatest importance in naval architecture. With the instruments and apparatus provided on this boat it is believed that more exact and definite data can be obtained than is possible by the usual methods of model tank experiments. The flexibility of control of the electric power plant and the means which it affords for the measurement of power and other factors entering into such problems should make it possible to secure these data with an unusual degree of refinement and at a comparatively small expense.

Aside from the experimental work, however, it is intended to demonstrate with this boat the advantages of applying electric drive to towing. In handling a tow of barges with an electric towboat it is proposed to generate the power on the towboat in the form of electricity, and then to transmit the power to the individual barges in the tow by means of a flexible conductor, each barge to be provided with its own propeller and motor with the control on either the barge itself or on the towboat. This method of towing, the author of the paper believes, will offer exceptional advantages for handling a tow in confined waters or in maneuvering about a harbor or in a canal and for increased economy in propulsion. It is also pointed out that with an electric power plant available on the towboat, power could be furnished not only for propelling the barges but also for operating refrigerating machinery for a cold storage system on the barges, so that cargoes of perishable goods could be transported economically by water.

Taking a step further, the author suggests the possibility of adapting an electric power boat to the propulsion of regular passenger boats with the advantage that by isolating the power generating plant in a separate hull the passenger boat could be made practically safe against sinking and against fire as well as eliminating the annoyances arising from the proximity of the power-generating plant on the boat itself. While such a scheme might not prove practicable for a large ocean-going liner, there is a class of steamers operating on short routes on sheltered waters where such an arrangement might prove feasible, with the special advantage that the power boat could be operated continuously. Under such conditions the power boat would become in reality a floating electric power station and the possibilities for the sale of its power, both ashore and afloat, would become almost unlimited.

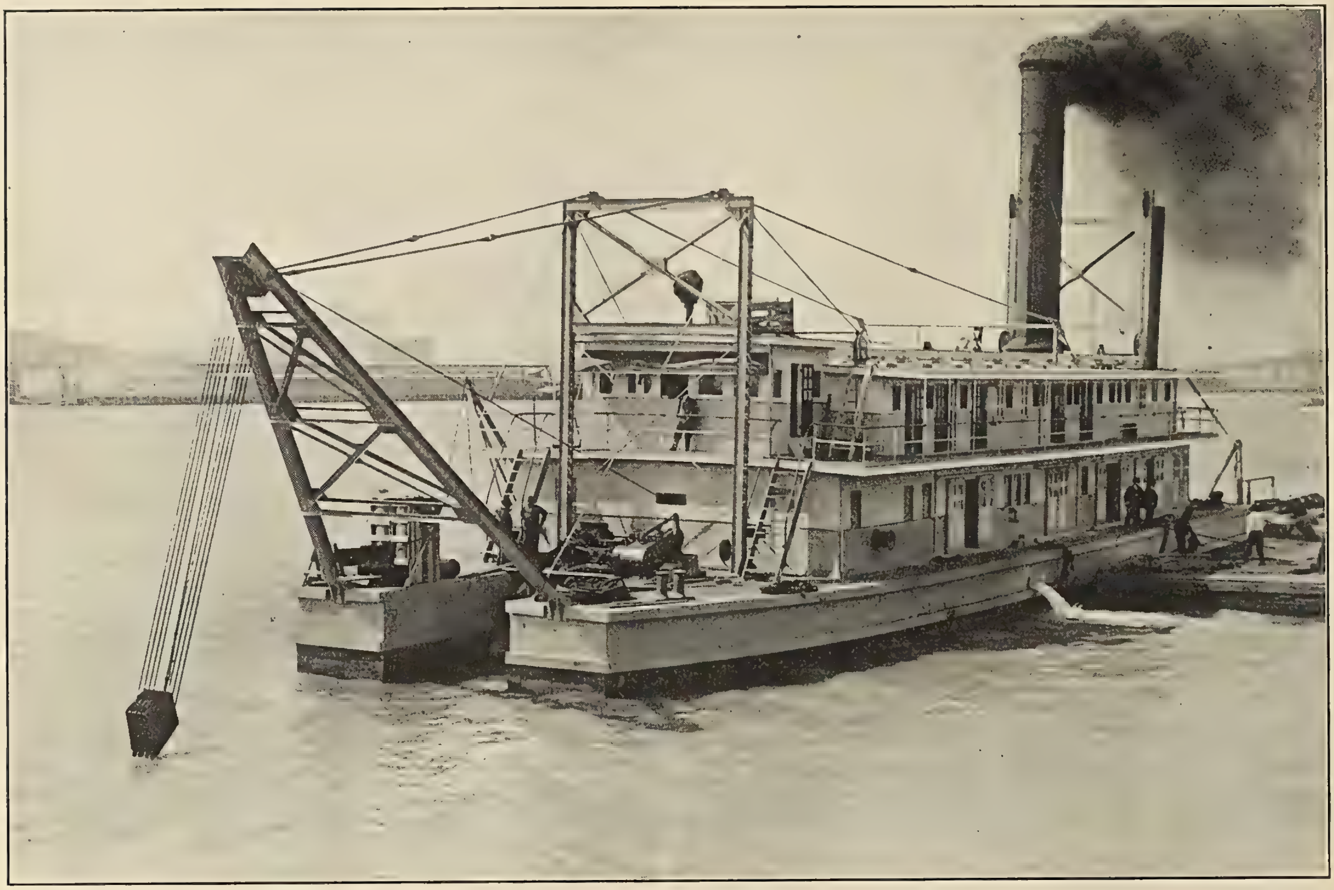


Fig. 1.—Government Dredge *San Jacinto* Undergoing Test

Fig. 2.—Controls in Lever Room

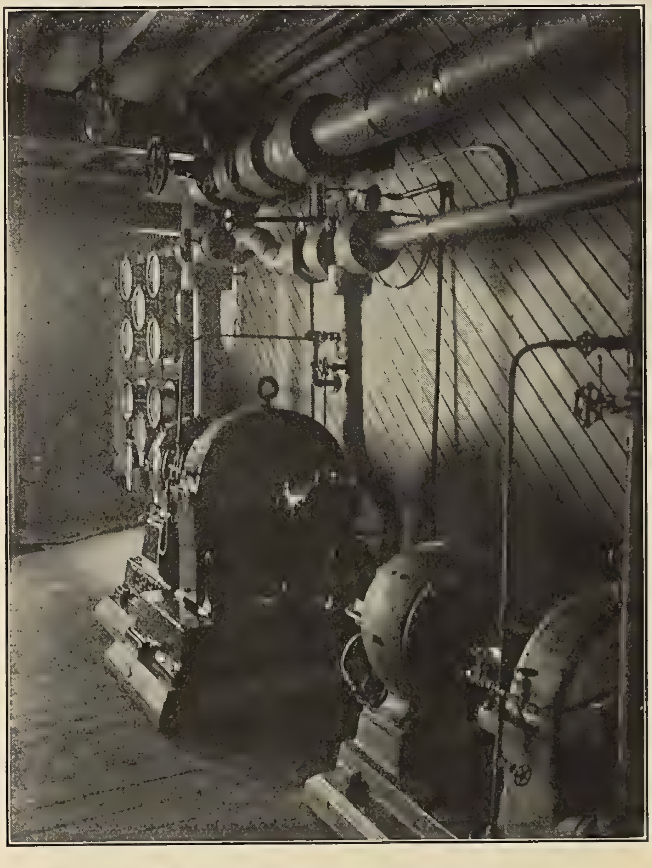


Fig. 3.—Terry Turbo Generating Sets

The Latest United States Dredges

Description of Two Suction Cutter Type Dredges Built for Improving the Houston Ship Canal

BY P. M. BRUNER

In Galveston, Tex., two of the latest type of cutter pipe line dredges are rapidly being completed by the Bowers Southern Dredging Company for the United States Government. These dredges, the *Sam Houston* and *San Jacinto,* will cost $200,000 (£41,000) apiece, one-half this sum being borne by the government, and the other half by the city of Houston. They will be used in the Houston ship canal, which connects Houston with the Gulf of Mexico, and for which two and a quarter million dollars (£513,000) was appropriated for improvements.

The hull was built in Orange, Tex., and then towed to Galveston to have the machinery installed and be completed. It is 148 feet in length with a 38-foot beam and a depth of 12 feet. The bottom planking is 4 inches by 12 inches, the sides 5 inches by 10 inches and the lumber Georgia long-leaf yellow pine.

The pumping engine is a vertical triple expansion condensing engine, the bore of the cylinders being 14, 22½ and 40 inches respectively and the stroke 20 inches. It was designed for a normal running speed of 180 revolutions per minute, but will run safely at 200 revolutions per minute and develops probably about 800 horsepower. This engine is direct-connected to the main dredging pump, which is of the single suction volute type with 21-inch suction, 20-inch discharge and 96-inch diameter runner. The engines and main pump are of the Bowers Southern Dredging Co. type, built by the Morris Machine Works.

This machinery is in a well in the hold about 20 feet wide and 30 feet long. The suction pipe runs out from the pump through the hull and along the cutter ladder to the cutter, the blades of which are so formed as to induce the material to enter the suction. The discharge pipe runs back through the hold and emerges at the left side of the stern above the waterline.

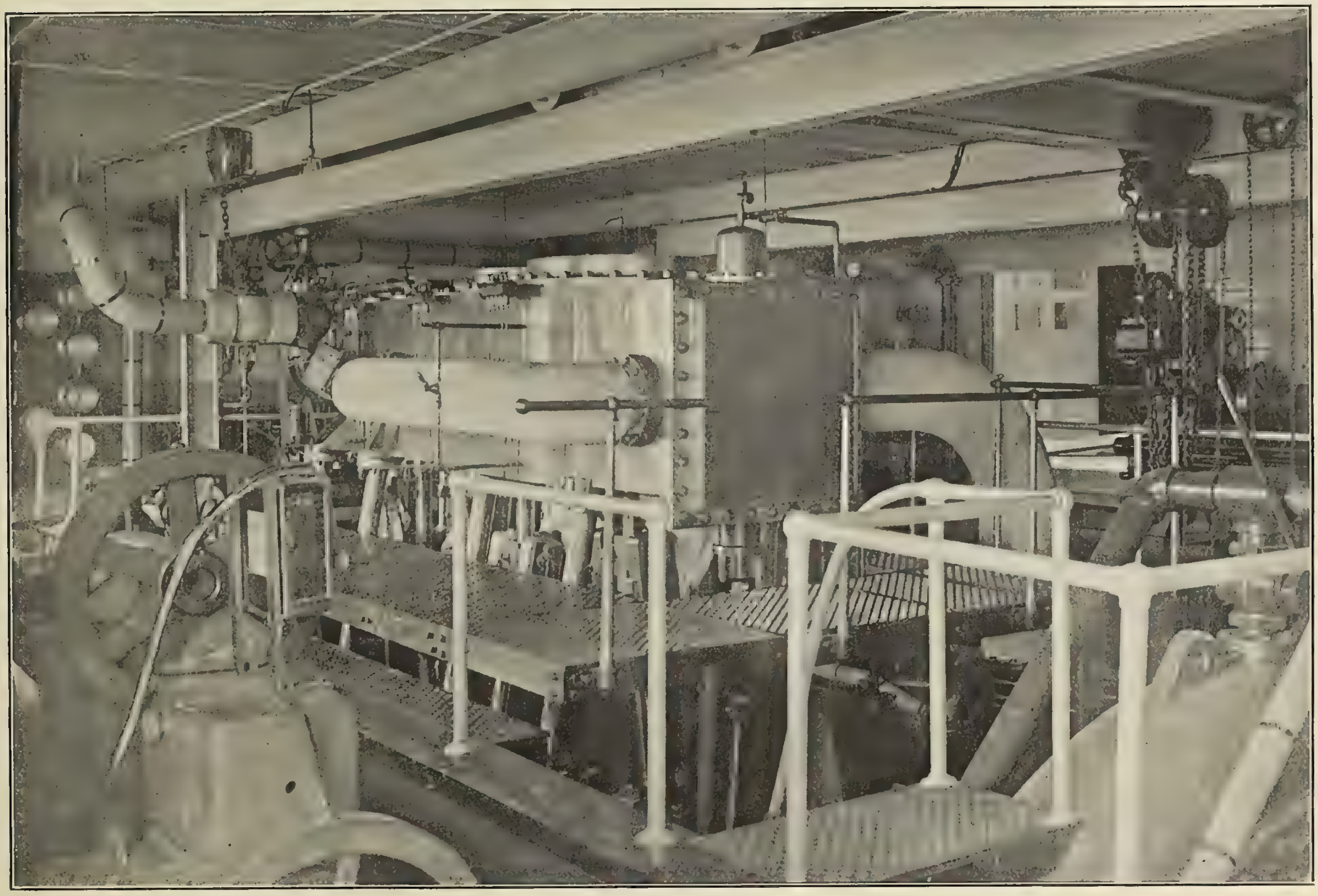


Fig. 4.—View of the Engine Room of the *San Jacinto*, showing Main Dredging Engine and Pump

The cutter ladder is the Bowers heavy I-beam construction and carries the suction pipe, cutter shaft and cutter. It is raised and lowered by means of the A-frame shown in the illustration. The cutter is of the Bowers extra heavy type and is driven by a double horizontal non-reversing 12-inch by 14-inch engine at a speed of thirteen revolutions per minute.

The spud frames are of the standard heavy construction and carry the spuds. These are long, heavy timbers with heavy pointed iron shoes and are let drop, thus anchoring the stern but allowing the dredge to turn on the spud acting as a pivot.

For swinging the dredge two 3,000-pound anchors are dropped some distance to the right and left forward of

Fig. 5.—Discharge from 10-inch Nozzle Representing 1,000 Feet of Pipe Line

Fig. 6.—Type of Metal Pontoons Used for Carrying the Pipe Line. Each Dredge Carries Forty of These Pontoons

the bow. These swinging wires lead to the forward end of the engine room, where the engines for swinging the dredge are located. The swing or width of channel possible to cut is 200 feet, and the dredge is capable of cutting this to a depth of 45 feet. The hoisting equipment was built by the Bowers Southern Dredging Company.

Each dredge carries as part of its equipment 40 cylindrical metal pontoons, 5,000 feet of pontoon line and 1,000 feet of shore pipe.

The boilers, of which each dredge has two, are of the Babcock & Wilcox type and have a working pressure of 225 pounds and are fired with oil burners of the Peabody type. A fuel tank installed forward of the fire room is 8 feet in diameter by 20 feet long.

In the hold forward of the engine a complete double-effect evaporating plant, supplied by the Griscom-Russell Company, is installed for producing make-up feed water for the dredge and for drinking, culinary and fresh water purposes. The plant has a capacity of 9,000 gallons distilled water per 24 hours, 1,000 of which is distilled, filtered and set aside for drinking purposes. Two fresh water tanks 4 feet in diameter by 15 feet long are installed in the wing compartments in way of the boiler room.

There are two turbo-generators of the Fort Wayne type, of 125 volts, direct-connected to Terry turbines; one of 15 kilowatts and the other of 10 kilowatts capacity. These will serve all the signal, search, arc, incandescent lights, fans and motors of General Electric make.

A complete blacksmith and machine shop is part of the equipment and is located on the main deck. The machine tools are all individual motor drive, the more important being a 20-inch lathe, 36-inch drill press, 24-inch shaper, bolt cutter, pipe machines for cutting and threading pipe up to 6 inches in diameter and a complete outfit of grinding tools supplied by the Niles-Bement-Pond Company.

The lever room forward on the upper deck has glass windows and doors to give a view on all sides and is so arranged that the spuds in the rear can also be seen. All the dredging machinery is controlled from this room. All handles, levers and valves necessary for this purpose are led from the several clutches, brakes and engines through the upper deck and to the lever room, where they are so arranged for handling that the lever man may at all times have a full view of the various operations. Each lever and clutch handle is plainly marked with the name of the part it controls and the room is fitted with gongs, speaking tubes and gages, which are in full view of the operator. A searchlight mounted on top of this room and operated from it is of 35 amperes capacity and has an 18-inch reflector.

Every convenience for the crew is provided. The whole boat is electrically lighted and large fans ventilate the upper deck, which is given over almost completely to the crew. A one-ton capacity Brunswick direct expansion ammonia type ice machine furnishes plenty of ice and is arranged for cooling a cold storage room on the upper deck. In cool weather the rooms are heated with steam wall radiators. The rooms of the captain and chief engineer have all these conveniences, together with a wash-

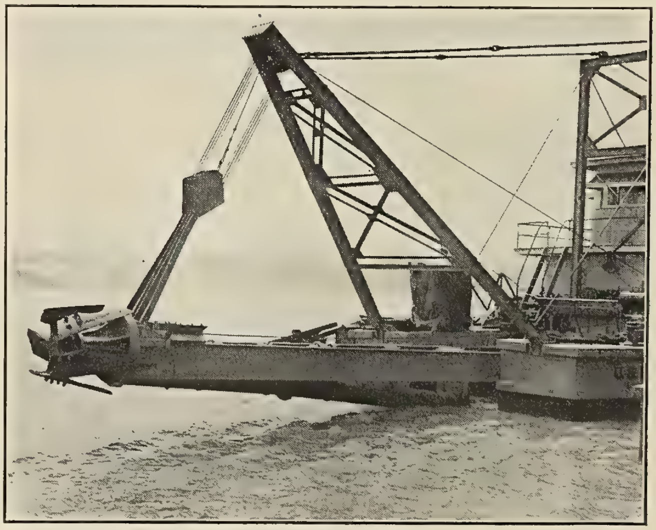


Fig. 7.—Cutter and Suction Pipe

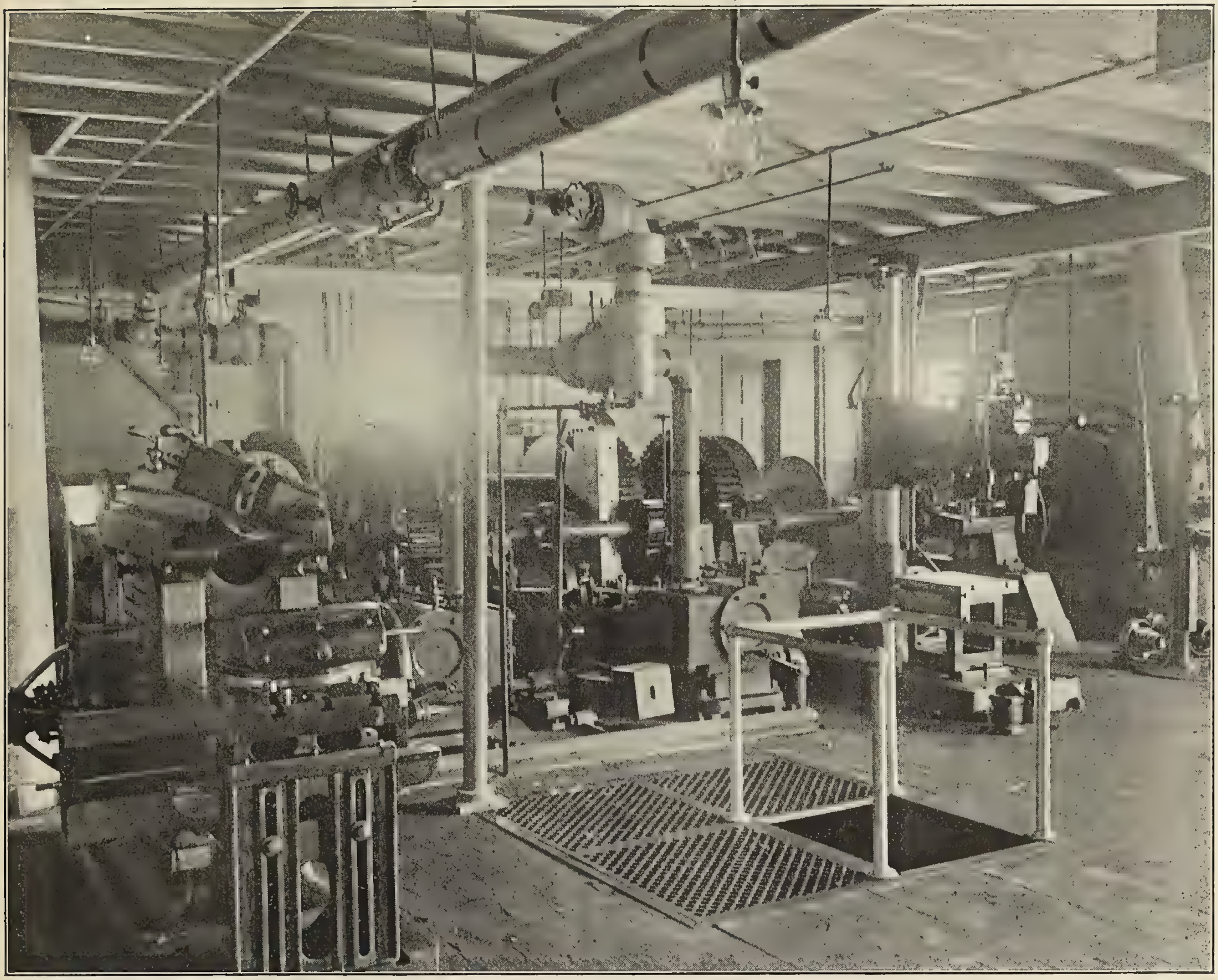


Fig. 8.—Forward Part of Engine Room, Showing Some of the Machine Tools and also the Engines for Swinging the Dredge and Raising and Lowering the Cutter

stand, and a private bath is provided for the chief officers. The crew have double iron bunks and their bath rooms, one on the upper and one the lower deck, are fitted out with showers. The office is equipped with oak roll-top desk, typewriter, letter copying stand, letter press, revolving chair and berth.

The *San Jacinto* has gone into commission and is in charge of Captain A. F. Symms, who has been in the government service sixteen years, ten years of which was spent in the Galveston district. He was then transferred to Panama and served as master and supervisor of the dredges on the Atlantic side. The chief engineer of the dredge is Mr. R. P. Prendergast, who for sixteen years has been in the service of the government and of the North American Dredging Company. Mr. Prendergast was chief engineer of most of the large government dredges at Galveston and was then transferred to the engineering department at Seattle, Wash., finally being transferred back to Galveston. This work was under the supervision of Captain George M. Prendergast, who has had charge of the Galveston district for twenty years.

Dredge Tender for U. S. Army Engineers

Last October the War Department of the United States Government requested naval architects to submit sketches for a proposed tender for the use of the United States army engineers' office at Galveston, Tex. A number were submitted, but the design by William J. Deed, Jr., of Boston, was selected. The boat is now under construction by the United States army engineers at Galveston. She will be called the *Victoria* and will be in use by the time operations are begun on the channels of the Texas coast.

The boat will be 34 feet length overall, 33 feet 3 inches length on the waterline, 8 feet 8 inches breadth over planking, and 2 feet 11 inches draft. The lines have been drawn with a view to producing a boat that will tow without squatting and also drive easily when running without a load. She is provided with heavy towing bitts for handling barges and has bitts well amidships for handling the barges in the narrow channels and bayous. She also has towboat fenders and bumpers and very heavy guards. A derrick mast operated by hand is provided, as spare parts and supplies for the dredges will be carried. A hunting cabin provides quarters with 6 feet 1 inch head room, cooking, sleeping and toilet accommodations.

The motor will be a four-cylinder, four-cycle, 5¾-inch by 7¼-inch Twentieth Century, and will drive the boat better than 10 miles an hour. Controls for the motor are brought to the steering wheel so that the boat will be a one-man craft. She will have Sands plumbing, and fuel tanks of 132 gallons capacity of seamless steel made by Janney, Steinmetz & Co.

Reconstruction of U. S. Dredge Barnard

BY J. R. PEYTON

The twin screw dredge *Barnard* was built by the New York Shipbuilding Company in 1904, to assist in opening the South West Pass of the Mississippi River. The general dimensions are: Length, 213 feet; beam, 38 feet; depth, 14 feet 6 inches; draft, 8 feet. The propelling engine room is at the stern, with the pumping engine room forward, the boiler room being between them.

Originally there was a well on the centerline of the hull 7 feet wide, beginning 28 feet from the bow and extending aft for a distance of 60 feet. A suction pipe with drag head rested on trunnions at the forward end of the well. The pumping installation consisted of a 36-inch double suction centrifugal pump directly connected to a triple expansion engine. The discharge pipe leads to either side and to the stern.

The method of dredging was to cruise up and down the cut, towing the pontoon discharge pipe line at the side, it being held abreast of the dredge by either a self-propelling scow or by a baffle plate at the discharge end. This process was found to be impractical and the material was discharged directly overboard at the stern, depending on the current to carry it over the bar into deep water.

After working in several localities, it was decided to convert the *Barnard* into a cutter dredge of the spud pipeline type, it being considered impractical to combine successfully a bar and harbor dredge. The work was done at the Navy Yard, Charleston, S. C. The old pumping installation was replaced by a 22-inch single suction steel pump of the volute type. It is directly connected to a triple expansion engine having cylinders 17, 22½ and 40 inches in diameter with a common stroke of 20 inches and placed athwartship.

The center well was extended to the bow and the after end closed for a distance of 29 feet. The well is decked over at the bow. A cutter ladder 60 feet long and weighing about 65 tons was placed on trunnions at the after end of the new well. A 10-inch by 12-inch double horizontal non-reversible cutter engine was placed fore and aft on the ladder over the trunnions. A minimum of vibration is thus secured. The 7½-inch cutter shaft is driven through cast steel cut gearing and is provided with a heavy thrust bearing. The cutter is cast steel and of the spiral type as seen in Fig. 2. A ball joint makes the flexible connection in the suction pipe at the hull. There is no stone box. The dredge can dig to a depth of 35 feet and make a cut 300 feet wide on one advance. The A-frame back stays were secured to the structural runway over the old well formerly used to handle the suction head.

The spuds are Oregon fir, 33 inches in diameter and 60 feet long, and are reinforced with strips of Swedish iron. One spud was placed inboard and the other outboard of the propeller shafts. The spud gallows frame extends 36 feet above the deck. The winding machinery is operated by a double horizontal reversible 8½-inch by 12-inch engine and is located on the main deck forward of the pumping engine room.

Fig. 2.—The Reconstructed Dredge *Barnard*

The combined pilot house and lever room was moved 46 feet forward. The distance being considered too great to operate the ordinary hand levers, a system of hydraulic control to the winding machinery and the cutter engine was installed. A pressure of about 60 pounds per square inch is maintained by a duplex pump with an automatic pressure regulator. The system is piped up to a fresh water tank and includes a spare pump. The hydraulic cylinders are proportioned to produce about 750 pounds piston thrust to operate the frictions and brakes. This installation has proved satisfactory in service.

Fig. 1.—Twin Screw Dredge *Barnard* as Originally Constructed

An extensive series of nozzle tests was conducted by utilizing a nozzle equivalent to 5,000 feet of 22-inch discharge pipe. The discharge pressure was 43 pounds per square inch at 165 revolutions per minute of the pumping engine. A ship's taffrail log was used in the hull discharge pipe to determine the velocity of the discharge.

The open well does not affect the steering qualities of the dredge and she can maintain a speed at sea of about 9 knots. The *Barnard* is now engaged on the improve-

ment of Tampa harbor, Florida, and her performance there has shown the superiority of the present method of operation.

Hydraulic Dredge for Cuyahoga River Improvement

BY H. FIES *

At the new plant of the Otis Steel Company, in Brooklyn, O., a suburb of Cleveland, an interesting engineering project is now under way, involving the reclamation of some very valuable land and the straightening of the Cuyahoga River. At this point, and along the foot of a range of hills, the river makes a semi-circular bend about a mile in diameter and traversing a tract of ground containing about 350 acres, which heretofore has lain idle. It was decided to cut a new channel for the river directly across

Fig. 1.—Electrically Driven Hydraulic Dredge for Cuyahoga River Improvement

the base of this curve and to use the spoil from the cut to fill in the ground for the new steel works. The buildings for the plant had been previously built on concrete piers to permit the elevation of the land to be raised from 4 to 15 feet above the old level. Directly in the path of the new channel was a hill about 200 feet high, through which it was necessary to cut and which it was decided to cut entirely down in order to obtain sufficient material for completing the reclamation work and for filling in the old river channel.

The contract for the excavating and filling was let to P. T. McCourt, contractor, of Akron, O., who decided that the most feasible method of operation would be to cut down the hill with steam shovels and to excavate the new channel with a hydraulic dredge, the latter at the same time to fill in the low ground through a long pipe line. Work was accordingly started on the hill last spring with two

* Mechanical Engineer, the Marion Steam Shovel Company, Marion, O.

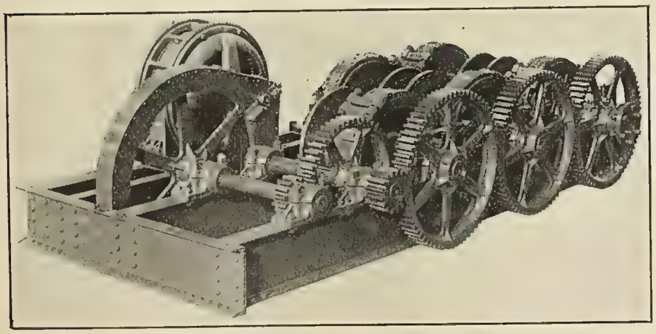


Fig. 2.—Five-Drum Winch

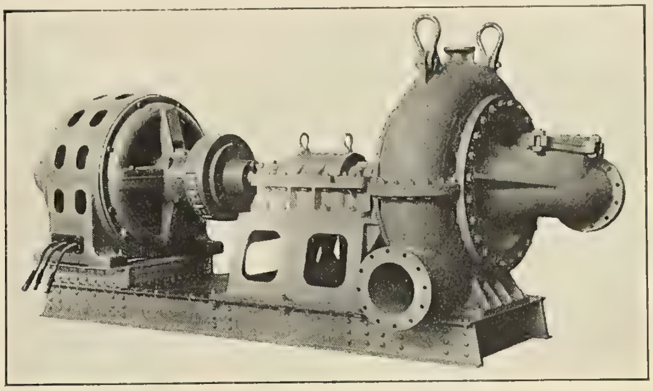


Fig. 3.—Main Dredging Pump

Marion Model 61 steam shovels, using dump cars to deliver the spoil to the various points around the hill which required filling.

The hydraulic dredge for this work is of special design (Fig. 1) and was built complete by the Marion Steam Shovel Company, Marion, O. The hull is 80 feet long, 25 feet wide and 5 feet deep, built of steel throughout. The frames of the hull run atwartship and consist of channels, top and bottom, with vertical angles connected to them by gusset plates. Two fore and aft trusses provide the necessary longitudinal stiffness, these trusses being connected directly to both the top and bottom members of the cross frames. All plating for the bottom, sides and deck is laid fore and aft, the after part of the deck between the trusses being cut out to form a cockpit for the dredging pump. The bow and stern gantries are also of steel,

Fig. 4

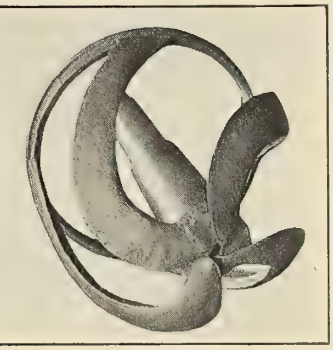


Fig. 5

the stern gantry being directly connected to the stern of the dredge and the after end of the main trusses, while the bow gantry is pin-connected to supports on the deck and held in place by steel cables fastened to the forward end of the main trusses.

The pilot house is built on top of the fore and aft trusses, and so placed that the operator can have a clear view of the work at all times. The pilot house contains the winch levers, gages, switchboard and all controlling apparatus, so that every operation of the dredge is controlled by one man. The switchboard consists of three slate panels mounted on a pipe framework. On these panels are mounted a voltmeter and an ammeter, together with the

circuit breakers and fuses protecting the various power and lighting circuits. The lighting system is supplied with current taken from the secondary of a 5-kva transformer. A ten-inch searchlight is installed so it can be used either on the bank or pontoon line. All machinery is driven by 3-phase, 60-cycle, 2,200-volt, General Electric Company motors, the variable speed motors being of slip-ring type, equipped with fourteen point reversing controllers. The current is brought on board by a flexible submarine cable connected to transmission lines running parallel to the cut.

The main dredging pump has 16-inch suction and discharge openings and, by means of a flexible insulating coupling, is direct connected to a 300-horsepower motor mounted on the same bed plate (Fig. 3). The pump is designed to deliver 225 cubic yards of solid material per hour through 1,000 feet of discharge pipe and to an elevation of 12 feet above the waterline when running at 345 revolutions per minute. Owing to the great variation in the length of the discharge line required at various times, the motor was provided with controlling apparatus for running continuously with 25 percent speed reduction.

In order to knock down part of the hill and sluice material into the cut immediately ahead, a 2-inch hydraulic giant is mounted on the bow of the dredge in such a way that it can be swung independently and have a large radius of action. Water for the giant is provided by a 6-inch, 3-stage, Worthington turbine pump, delivering 1,300 gallons per minute at a head of 360 feet, and which is direct connected to a 200-horsepower motor operating at 1,140 revolutions per minute. A 3-inch Worthington volute pump, direct-connected to a 15-horsepower motor, operating at 1,140 revolutions per minute, is provided for fire protection, hosing off the deck, priming the main pump and for the various water-sealed stuffing boxes on the pumps and suction pipe.

A 5-drum winch (Fig. 2) driven by a 20-horsepower motor is used for handling the swinging lines, raising the cutter ladder and operating the spuds. The motor is provided with controlling apparatus for any variation in speed from full speed down to half speed and is also fitted with solenoid brake. The motor is direct-geared through intermediate shafts to the drum shafts. Each drum is provided with internal expanding friction and outside brake band, each one of which is separately controlled from the pilot house.

The cutter drive and suction pipe are mounted on a structural steel ladder, suspended at the bow of the dredge on steel trunnions. Through one of these the suction pipe passes and the joint is sealed to exclude air by means of water forced into the packing by the 3-inch pump. The ladder is raised and lowered by cables running over sheaves in the top of the bow gantry and down to a drum on the winch machinery. The cutter is driven through reduction gearing by a 75-horsepower motor, running normally at 575 revolutions per minute, but fitted with controlling apparatus for operating continuously at 50 percent speed reduction. The cutter originally furnished was of the heavy type, having removable manganese blades, but after the dredge had been put into operation the sub-soil was found to consist of sticky blue clay of the sort commonly called "Gumbo," and the cutter was found to be unsatisfactory, owing to the material clogging it up and refusing to enter the suction pipe. A cutter was then installed having four knife-like blades, curved in the shape of an auger (Fig. 4), which was found to do excellent work. This cutter was later replaced with one of the same pattern, but of greater length (Fig. 5), as it was found difficult to properly gage the forward steps of the dredge with any great accuracy, the tendency being to overstep and leave uncut material behind the cutter. A great deal of trouble and delay has been caused by logs imbedded in the soil and which must be pulled out before the dredge can proceed. Some of these logs are 24 inches in diameter and 35 feet long, and as many as six have been found in the cut at one time.

The new channel will be 8 feet deep and 150 feet wide, and later it may be deepened to permit navigation. When this is done the Otis Steel Company contemplates the building of docks on the west bank of the river.

Types of Dredgers Built in the United Kingdom

The best known types of marine dredgers built in the United Kingdom are bucket ladder dregders ("hopper" and "barge-loading"), cutter suction hopper and reclamation dredgers, and trailing suction hopper dredgers. It should be added, however, and perhaps emphasized, that the types named vary in essential details and features with the varying conditions prevailing in the different ports, harbors and rivers in which they are employed.

The introduction of dredging machines into the United Kingdom is generally placed in the reign of Charles I, when some Dutch engineers came over to carry out improvements connected with the great Bedford level. About the middle of the second half of the eighteenth century considerable improvements were effected in dredging appliances, particularly in connection with dredging operations on the Clyde, and further improvements were made in 1805 in connection with the deepening of the Thames.

The application of steam propelling power to dredging vessels was made in 1861 in the construction by William Simons & Co., Ltd., Renfrew, of two hopper steamers to the order of the Trustees of the Clyde Navigation. These were the first self-propelling vessels employed for transporting and depositing dredgings in deep water. Experience has amply demonstrated on the Clyde, Thames and Mersey, and on many other rivers and canals, that the substitution of "steam hoppers" for tugs, with their string of punts or scows, was a step in the right direction.

A later development was brought about by combining in one vessel the distinctive features of the bucket ladder dredger and of the steam hopper barge, which resulted in building the type of dredger now known as the "hopper" dredger. The first vessel of this type was the *Canada*, constructed by Messrs. Simons & Co. in 1872 to the order of the Dominion Government. The most powerful dredger of this type yet constructed is the *Corozal*, described in previous issues of this journal, which was built for service at the Panama Canal. A record made by this dredger was the excavation of 13,700 cubic yards of material, 90 percent of which was rock, in 19 hours 50 minutes.

In recent years remarkable developments have taken place in the application of suction dredging by the introduction of mechanical devices working in front of the suction nozzle. This type of dredger is now able to handle many different kinds of material, ranging up to the stiffest class of blue clay, chalk and soft rock, whereas formerly they could be used profitable only in sand or sand and silt. The cutter suction type of dredger has an advantage over the bucket ladder dredger in that there are fewer parts subject to wear.

A still further development of the suction dredger is known as the trailing suction dredger, in which a trailing suction pipe, having an elongated suction opening, is employed. This type of dredger works without moorings and has proved very efficient and economical where material of a soft, silty, clayey nature is met.

Four-Yard Government Dipper Dredges

Description of Government Dredges Davenport, Keokuk and St. Paul, Built for Improving the Upper Mississippi River

During the season of 1914 the United States Government completed the three four-yard dipper dredges *Davenport, Keokuk* and *St. Paul.* These dredges were designed and built at Rock Island, Ill., for use in improving the upper Mississippi River between St. Louis and St. Paul. One dredge is now in service below the new government lock at Keokuk, Iowa, another on the Rock Island Rapids just above Rock Island, Ill., and the third in the vicinity of Minneapolis. The three dredges are similar in all respects.

The dredges have steel hulls, with single-deck wooden cabins built on a skeleton framework of steel cabin and roof trusses. All the machinery, with the exception of the capstan engines, is located on the main deck, making it convenient to operate, maintain and repair same and avoiding the necessity of large openings in the deck with consequent loss of strength. The main hoisting engines are located on the centerline of the hull about amidships, the large gears projecting slightly through an opening in the deck. The forward spud engines are placed on each side of the main engines and the swinging engine forward and starboard of the main engines. The main boiler is located just aft of the main engines. All machinery is controlled from the operator's stand.

Hull Construction

The hull is constructed of open hearth steel, 110 feet in length, 40 feet beam and 6 feet depth, with a 6-inch crown to the deck. The forward end of the hull is square except for a 12-inch cut-off at the bottom on the angle taken by the dipper handle when in its lowest position, which thus presents a flat surface instead of a sharp corner for the dipper to strike against and permits digging closer to the hull than would otherwise be possible. The after rake is brought up on an easy curve in order to present the least possible resistance when the dredge is being towed stern foremost.

In order to take care of the strains to which it is subjected when spudded up and digging rock, the hull was made exceptionally strong and rigid, and the maximum fiber stress was kept at a very low figure. The hull is framed fore and aft in order to obtain maximum strength with minimum weight. The deck and floor beams are 6-inch ship channels extending the entire length of the hull. Two fore and aft watertight bulkheads extend the length of the hull, at a distance of 9 feet 9 inches from the gunwale, and in addition there are two fore and aft trusses, spaced 2 feet 6 inches on each side of the centerline, to provide additional stiffness and act as supports for the boiler and machinery.

Two transverse watertight bulkheads divide the hull into nine watertight compartments. The transverse bulkheads are made watertight, where pierced by floor and deck beams, by the use of cast-steel staples calked watertight. Transverse trusses are worked every 11 feet throughout the length of the hull. The plating is 3/8 inch thick for two-thirds of the length amidships and 1/4 inch thick at the two ends. A suction tank, connected to the river by a 6-inch valve, is provided in the hull as a source of supply for the pumps and injectors. Doubling plates are provided under all machinery, boilers, sheave brackets, cavels, chocks, etc., and in way of all manholes and openings in the deck.

Spuds and Spud Wells

The forward spud wells, located outside of the gunwale 5 feet from the bow, are secured to the hull by a system of plate and angle brackets and are built up of 7-16-inch plates extending 12 feet above the deck. The outboard side of the well is open to permit the removal of the spud and the spud is held in place by cast steel gates. The well is stiffened by fore and aft, as well as transverse, diagonal channel struts. The spuds are of Oregon fir, 30 inches by 30 inches by 38 feet long, and are fitted with 30-inch steel bronze bushed sheaves mounted on top and in a mortised slot just above the shoe for the spudding up and lifting cables.

The after spud well is formed by a slot in the rake along the centerline of the hull to accommodate a 20-inch by 20-inch walking spud. The spud shoes are rectangular steel castings with detachable conical crucible steel points which are interchangeable. The points are considerably smaller than the bottom of the shoe, leaving sufficient bearing surface to prevent the spud from unnecessary sinking in soft material. Broken or dulled points are very easily renewed.

The dredging machinery proper was furnished under contract by the Marion-Osgood Company, Marion, Ohio. The machinery was designed for digging to a maximum depth of 18 feet and a minimum depth of 6 feet, and for adequate power for handling a four-yard dipper in ordinary material. An extra heavy and wide two-yard dipper with teeth was furnished for digging rock with a low face. The parts were designed, with an ample margin of safety, so as to stall the engine with 125 pounds boiler pressure.

Main Engines

The main engine is double-cylinder, 12 inches bore by 16 inches stroke, non-reversible, with hoisting drum compound geared ahead of the engines and backing drum forward of hoisting drum. It is mounted on a heavy structural frame of 20-inch I-beams and plates giving straight leads above deck for the hoisting rope and backing chain. The hoisting drum is of steel, 45 inches in diameter and grooved. The backing drum is of steel, 27 inches in diameter and smooth. An extra gear and pinion is provided for changing the ratio of gearing for double hitch between point of boom and dipper. All gears are of cast steel with cut teeth. Frictions are of the outside band type set up by steam rams bolted to the gears. The lowering band is operated by foot through a powerful toggle connection. The main throttle is of the balanced piston type. All engine cylinders are fitted with automatic cylinder cocks.

The swinging engines are 8 inches bore by 8 inches stroke, double cylinder, reversible, with central valve, compound geared, and mounted on a framework of 12-inch I-beams. The gears are of cast steel with cut teeth and the drum is 26 inches in diameter and grooved for a 1 3/8-inch swinging rope.

Spud Engines

The forward spud engines are exact duplicates of the swinging engine; but in addition have a brake wheel mounted upon the intermediate shaft for holding the spud in any position. The wheel is 42 inches in diameter, fitted with a heavy band lined with maple blocks and locked by

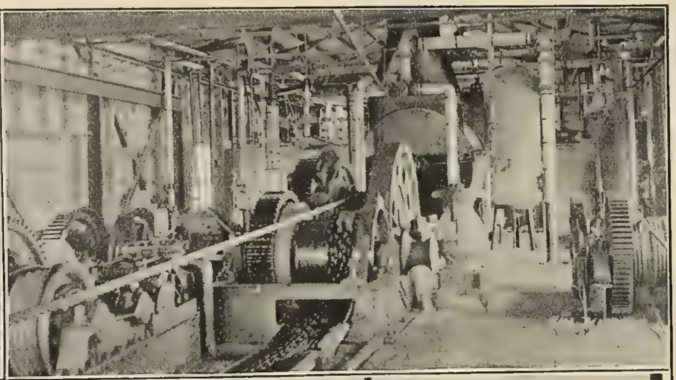


Fig. 1.—Dredge *Keokuk* in Operation at Keokuk
Fig. 3.—Dipper Lowered for Digging
Fig. 5.—Picking Up the Load

Fig. 2.—Interior of Dredge *Davenport*
Fig. 4.—Boiler for Dredge *St. Paul*
Fig. 6.—Dumping the Load

means of powerful toggle levers operated by hand from the operator's house. The spudding up and lifting cables are operated through suitable guide sheaves and the engines have sufficient power to raise the bow of the dredge high enough to insure absolute stability for digging.

The after spud engines are 6 inches bore by 6-inch stroke, double cylinder, reversible by a central valve, and are of similar construction to the swinging engines. The after spud drum is of cast iron, 17 inches in diameter, keyed on a 4-inch shaft which is mounted, together with the intermediate shaft, directly upon the after spud well casing. The intermediate shaft is fitted with a jaw clutch for disengaging the engine and with a brake wheel for holding the spud.

The swinging circle is mounted on a heavy steel base casting, bolted directly to the deck and having a lip projecting over the forward end of the hull. This lip is bolted to the hull and carries a backing chain guide sheave. The backing chain leads above deck through a cored hole in the base casting. The journal is 3 feet 5 inches in diameter and 12 inches high. The center casting is also of steel and to it is riveted the swinging circle, 15 feet in diameter, which is built up of 6-inch by 4-inch and 5-inch by 3½-inch angles and plates with a rim of 7-inch ship channel. Eye-bolts for attaching the ends of the swinging rope are arranged for taking up the stretch of the ropes and are provided with springs for absorbing shocks. Between the base and the center are a cast iron bushing and a cast iron plate to take up wear. On the center are mounted two sheaves grooved for 1¾-inch rope, 4 feet pitch diameter; between which the hoisting rope passes. The sheaves are of cast steel bronze bushed.

Boom

The boom is about 45 feet long from center of hinge pins to center of point sheaves. The main corner angles are extended beyond these sheaves with a shaft from which are hung two double tackle-blocks for lifting large rocks from the dipper. The boom is constructed of steel angles and plates, strongly braced. The corner angles are 8 inches by 8 inches, outside reinforcing angles 4 inches by 4 inches, and girder angles for dipper handle 6 inches by 4 inches. The point and heel sheaves are 64-inch pitch diameter, grooved for 1¾-inch rope and bronze bushed. Four 1½-inch wire rope boom guys extend from the point of the boom to the A-frame head.

The A-frame stands about 48 feet high above deck and is built up of four 15-inch channels and plates, braced and riveted. All castings are of steel, including bases, which are 48 inches by 24 inches. The top casting has a journal 13½ inches in diameter with a ¾-inch phosphor-bronze bushing, on which the revolving collar of steel works. A-frame back guys, 2¼-inch cast steel, 6 x 19 wire rope, extend from the A-frame to steel plate brackets at the extreme after corners of the hull.

Dippers

The rock dipper is 2 cubic yards capacity, struck measurement, with mangenese steel front and lip, cast steel back, and four extra heavy forged teeth. In order to give the dipper unusual width for its size, the front and back castings of a 3-yard dipper were used, and the distance from front to back reduced in proportion. The front and lip are separate castings, so that the lip may be removed without the front. The hoisting line is attached to the back of the dipper and no bail is used. A bail sheave and forged case is supplied for use in case a double hitch is rigged.

The dipper handle is built up of two white oak sticks, each 7 inches by 18 inches and 36 feet long. It is armored with heavy 7-inch ship channels top and bottom, and on top is a bar 1¼ inches thick, counterbored for the nuts of the rack bolts, thus leaving a smooth surface for the slide of the yoke block. The rack is of cast steel, 2½-inch pitch, shrouded and bolted to the handle. The end castings for attaching dipper and braces are of steel.

The shipper shaft is of hammered steel, 5½ inches in diameter, with square sections for pinions and brake wheels. The pinions are cast steel, 13 inches in diameter, and the brake wheels, one on each end of the shaft, are 60 inches in diameter and fitted with brake bands lined with maple blocks. Both bands are connected to one lever, which has both hand lever and foot pad. The yoke block is of cast iron with a cast steel cap and slide. The cap is bronze bushed.

Traveling Crane

A traveling crane is installed over the engines for moving heavy pieces of machinery. A 12-inch channel, extending from the boiler forward on each side, is supported by vertical channel posts secured to the cabin trusses on each side and forms the track for the crane. This track is spanned by two channels mounted on wheels running on tracks on the side channels. Two four-wheel trolleys, each carrying a 3-ton chain hoist, run on the thwartship channels, making it possible to pick up or place machinery in any part of the engine room.

The main hoisting line is a 1¾-inch wire rope and is made fast to the dipper and leads up over the boom point sheave and down under the heel sheave through the two sheaves on the swinging circle and back to the drum on the main engine. A guide sheave is located on the engine frame just forward of the backing drum to prevent the hoisting line from rubbing on the backing chain. The backing chain is 1¼-inch tested dredge chain and is made fast to the dipper handle at the dipper. It leads over a fair lead sheave free to turn about a vertical shaft in a bracket riveted to the front of the hull under the lip of the swinging circle base casting and then over a sheave which travels transversely on a shaft in the lip of the base casting, back through the casting and along an oak plank runway to the backing drum on the main engine. The swinging line leads from the rim channel of the swinging circle through two horizontal sheaves located aft of the swinging circle back to the swinging engine.

Boiler

The main boiler is of the locomotive firebox type, 6 feet 6 inches in diameter by 20 feet 6 inches long, and was designed particularly with a view toward the best possible economy in coal consumption after extended investigation into the coal consumption on other dipper dredges. The boiler was built for a working pressure of 150 pounds and has a 7-foot firebox, 5 feet high, flared to 7 feet 5 inches at the bottom, surrounded by a 5-inch water leg. There are 255 two-inch flues and a steam dome 3 feet by 3 feet. The ratio of heating surface to grate surface is 35.6 : 1. The stack is 3 feet in diameter and 20 feet high. The boiler is fitted with interlocking shaking grates and soot blowers. Draft is furnished by an exhaust steam jet in the stack. The boiler and steam lines are heavily lagged.

A feed water heater of the multicoil type is provided and operated by exhaust steam from the engines. A settling tank is also provided into which the feed water passes after being preheated in the boiler and into which the scale-forming material is precipitated before the water is liberated in the boiler. In this manner trouble from scale deposits in the boiler is eliminated. The feed pump and general service pump are both automatically controlled by pump governors. An auxiliary boiler of the vertical submerged flue type is provided for emergency use, such as operating spuds, pumps or generating set when the main boiler is out of commission.

Electric Plant

The generating set is a 3½-kilowatt, 110-volt, direct-current, compound-wound generator directly connected to a 4½-inch by 4-inch vertical steam engine. The interior of the cabin is well lighted throughout with additional plugs for cutting in electric drills or extension lights for use in the watertight compartments in the hull. A row of lights is provided under the eaves on each side of the cabin for use when working a night shift, and two four-light clusters on the forward side of each spud well casing. The working area is further illuminated by a six-light cluster located on the point of the boom and facing down.

A steam capstan is located about amidships on each side of the cabin with 6-inch by 6-inch double-cylinder reversible engines installed below the deck in the hull. Two single-barrel hand capstans are located near the bow for convenience in handling lines from rock barges.

The cabin houses the machinery and no living quarters are provided, as it is the policy of this district to furnish separate quarter boats on which the crews live. In this way the heat, noise and discomfort incident to quarters on the dredge are eliminated. The cabin is of wood stiffened by steel trusses and is 80 by 30 feet. The cabin trusses act as additional stiffening for the hull. Roof purlins are carried on steel roof trusses. A ventilating monitor extends the entire length of the roof. Two coal bunkers are located at the after end of the cabin, each with a capacity of 15 tons of coal.

The operator's lever stand is arranged in a house on the port side, just forward of the main cabin with windows on three sides, allowing the operator free view in all directions. The forward spud throttle and brake levers, swinging engine throttle, backing drum ram throttle and hoisting drum ram throttle are banked as hand levers, with the main engine brake as a foot pedal and the main throttle and aft spud throttle overhead.

These dredges have proved very satisfactory. They have shown a capacity of 50 yards per hour in blasted rock and 200 yards per hour in gravel with a two-yard dipper, and have stood up well under severe conditions of digging.

A Twin-Screw Bucket Ladder Dredger and a Single-Screw Hopper Barge For Tasmania

BY F. C. COLEMAN

Messrs. Ferguson Brothers (Port Glasgow), Ltd., have recently delivered to the Marine Board of Launceston the twin-screw bucket dredger and the single-screw hopper barge illustrated in the photographs.

The dredger is of the bow-well center ladder type with side shoots arranged for discharging dredged material over either side into hopper barges. She is constructed substantially throughout for dredging hard material and is fitted with two sets of buckets, one set for 23 cubic feet capacity, the smaller set for 13 cubic feet capacity. Steam is supplied from two cylindrical return multitubular boilers. The main engines are compound surface condensing, so arranged that one or both can work the dredging machinery.

The whole of the gear, tumblers and bucket backs are of cast steel, the hoisting gear for the bucket ladder is of the double brake system driven by a powerful steam engine on the builders' improved system. Powerful steam winches are fitted at the bow and stern for manipulating mooring chains and holding the dredger up to its work.

The hopper barge is a single screw flush deck vessel with forecastle, 155 feet long by 30 feet by 13 feet 6 inches, and has been constructed substantially throughout for receiving hard material. Hopper doors are arranged in the bottom of the vessel for discharging the material overboard.

Steam is supplied by one cylindrical return multitubular boiler. The main engines are compound surface condensing fitted aft in the vessel with complete equipment of auxiliaries. The engine and boiler are powerful enough to drive the vessel at a speed of 10 knots.

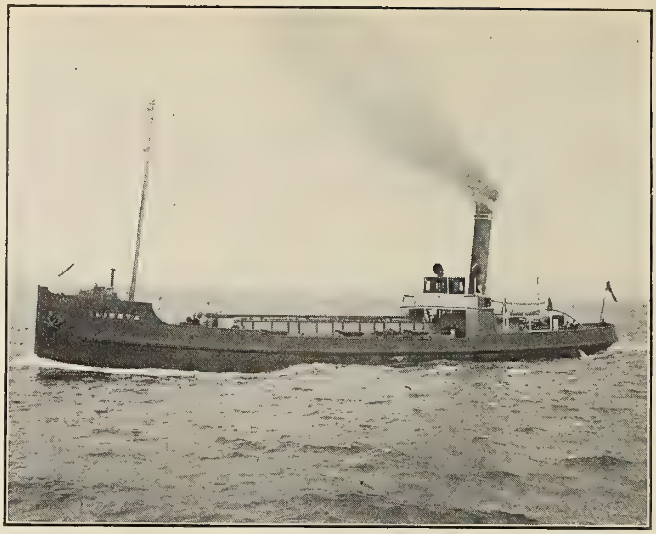


Fig. 2.—Single Screw Hopper Barge *Lienta*

A steam windlass is fitted on the forecastle deck and there is a steam winch on the deck forward of the hopper for lifting hopper doors. Sluices are arranged from the hopper to carry off the water. The vessel is fitted with electric light to give ample illumination throughout the vessel for dredging at night. There is a towing hook at the after end of the boiler casing with the necessary towing beam.

Accommodation for officers and men is fitted forward

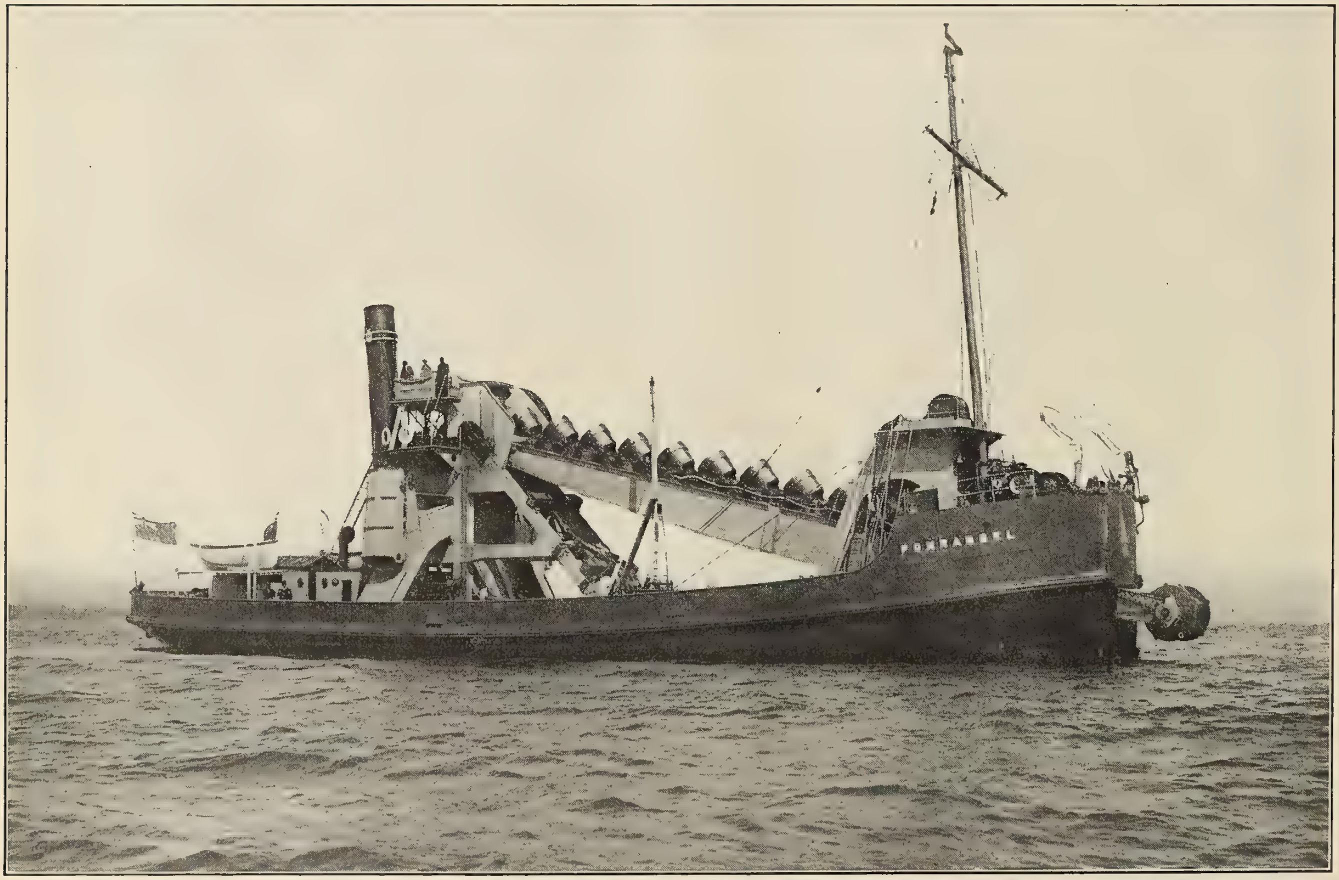


Fig. 1.—Bow-Well Center Ladder Dredger *Ponrabbel*

Fig. 1.—Fifteen-Inch Norbom Electric Dredge Operating in Lake Nokomis

and the galley and crew's lavatory are under the forecastle deck, the lamp room and officers' lavatory being under the bridge deck.

Both the dredger and hopper barge have been built, according to Lloyd's highest class, by Messrs. Ferguson Brothers (Port Glasgow) Ltd., under the direction of Mr. W. H. Hunter, consulting engineer, of Manchester.

Electrically-Driven Hydraulic Dredge

Last year the Park Board of the city of Minneapolis were undertaking improvement work on an extensive scale around Lake Nokomis, consisting of various kinds of excavation and filling-in, work eminently suitable for hydraulic dredging. The contract for this work was let to the Northern Dredge & Dock Company, of Duluth, Minn., and a 15-inch electric dredge (Fig. 1) for this work was built by the Norbom Engineering Company of Philadelphia, Pa.

While electrically driven centrifugal pumps have already been used successfully for many years, the electrically driven dredging pump presents certain features that must be given an earnest study if the dredge is to be a success. A small and fast rotating runner, such as is necessary with a direct connected motor, is very inefficient and soon wears out. Even the speed of an extremely slow speed motor, say, for instance, 350 revolutions, is a high speed for a dredging pump (except the minor sizes), and such motor is undesirable on account of its high cost, low efficiency and its bulk. A one-speed motor, whether of high or low speed, is too "rigid" to be desirable for a dredge that may one day be pumping against a 5-foot lift and 200 feet of pipe, and another day with a 25-foot lift and 2,000 feet of pipe line. If the motor and pump have been designed for effective work for the latter condition, it is practically useless on the former. If the speed is varied by resistance in the circuit through a controller, the waste of power is excessive. The only type then for direct connected motor and pump is a multiple speed motor, to which, however, there are many objections, principally its intricate construction or wiring, and its high cost.

The dredge above referred to is fitted with a comparatively large pump runner, 54-inch diameter, insuring an efficient working length of the vanes. It is driven at two speeds, about 300 and 250 revolutions by a 500 horsepower synchronous motor running at 720 revolutions, the speed reduction as well as speed change being effected through two sets of cut helical gears running in an enclosed casing, and oil lubricated. Fig. 2 shows this pumping unit assembled. A lever on top of the gear box, connected with a rigid clutch, will lock the gears in position for one speed or the other. With the synchronous motor, with a pump of ample and efficient size, and with this speed change device, the loss of efficiency of which is less than 2 percent, this unit may be considered as efficient and economical as can be had for dredging purposes, and the actual results show that for a period of over two months last fall the power consumption, with a pipe line varying from 500 feet to 2,000 feet, averaged from ½ to ¾ kilowatt hour per cubic yard of excavation. This consumption includes also the power taken by the auxiliary machinery, such as the cutter and winding machinery, water service pump, electric lights, etc.

The two speeds are sufficient, and are so proportioned that one is used with pipe lines up to 1,200 or 1,500 feet, and about 10 to 12 feet lift, while for more than this the high speed gears are being used. Under average conditions the dredge excavated 5,600 cubic yards per day, official measurement, while the daily maximum ran over 7,000 cubic yards in 24 hours.

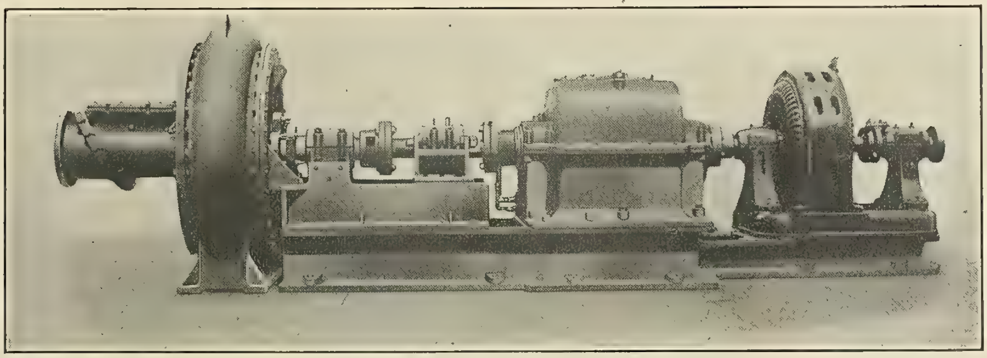


Fig. 2.—Motor-Driven Pump

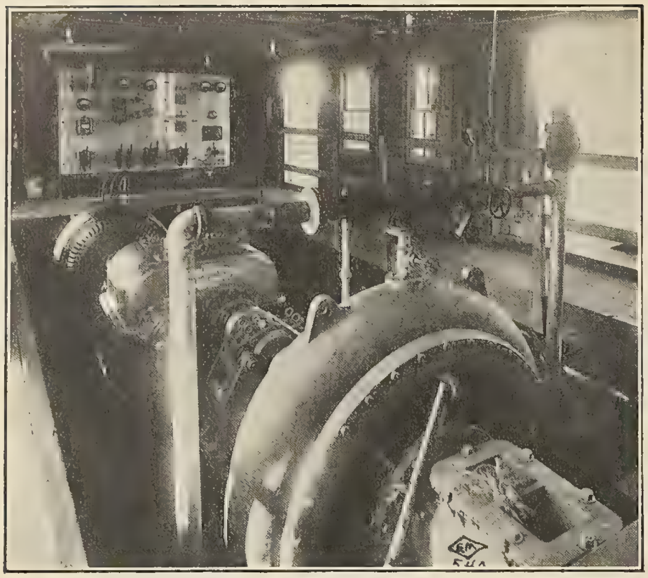


Fig. 3.—Interior of Dredge

The cutter machinery is operated by a 50 horsepower slip ring type motor, and is fitted with the Norbom Engineering Company's standard type cutter with interchangeable parts, as shown in Fig. 1. The operating or winding machinery is driven by a 30 horsepower slip ring type motor, and consists of five drums with frictions and brakes, and two winch heads.

A water jet exhauster operated from an auxiliary pump is used for priming the main pump, and there are provisions for fire service, water sealing of stuffing box on pump and of the ball joint on the ladder, and for pumping out the bilges.

The current is 2,300 volt alternating, three-phase, sixty cycles, used without transformation on the three principal motors. It is transformed to a low voltage for the service pump motor, and a motor-generator set installed for the purpose of giving direct current to a 6,000 candlepower searchlight; on this circuit is also inserted arc lights and incandescent lamps as well as an electric horn for signal purposes.

The hull is 80 feet long, 24 feet wide and 7 feet deep, and draws an average of 40 inches of water.

The photograph (Fig. 3) showing an interior of the dredge, was taken while the dredge was running, indicated by the blurred coupling on the pump shaft, and the rotor in the main motor. It is interesting to note how steady the machinery must have been running to allow of such sharp definition in the picture.

Government Dredges for Improving the Arkansas River

Two steel hull, stern wheel, shallow draft, 24-inch pump dredges, the *H. S. Taber* and the *Robert McGregor*, one of which is illustrated on this page, were built recently by the Dubuque Boat and Boiler Works, Dubuque, Iowa, for government service in improving the Arkansas River. The dimensions of the hull are as follows: Length between perpendiculars, 192 feet; length over all, 206 feet 9 inches; beam, molded, 44 feet 4 inches; depth, molded, 7 feet; draft, loaded, 3 feet 2 inches; displacement, loaded, 640 tons.

Two longitudinal and three transverse watertight bulkheads divide the hull into twelve watertight compartments. The main deck is of steel and the main deck house and the upper deck house of wood.

Steam for operating the dredge is furnished by three boilers of the Lyons type built by the Dubuque Boat & Boiler Works for a working pressure of 200 pounds per square inch. Each boiler has a grate surface of 45 square feet and a heating surface of 1,685 square feet. Induced draft is used and is supplied by three fans mounted on a platform over the boilers and connected to the uptake with a discharge leading into the base of the stack. The fans are 60 inches diameter and the engines 4½ by 5 inches of the inclosed, self-oiling type running at 535 revolutions per minute.

Government Dredge *H. S. Taber*, Built by the Dubuque Boat and Boiler Works

The propelling engines are simple engines 24 inches diameter by 48 inches stroke, built by Gillett, Eaton & Squire, Lake City, Minn., and fitted with Eaton independent inside valve drive. This drive is taken from the

pitman and thereby does away with the old style outside cam fitted to the shaft, with its necessary cam rods and brackets. The paddle wheels are arranged on the same shaft and are each 12 feet diameter by 12 feet long. The actual weight of the wheels is 62,000 pounds.

The main dredging pump is a 24-inch centrifugal, single suction pump of the shrouded type driven by a vertical triple expansion engine with cylinders 15, 22½ and 36 inches diameter and 18 inches stroke. The pump was built by the Morris Machine Works, Baldwinsville, N. Y. The condenser is of the Wheeler type with a cooling surface of 1,650 square feet.

One hauling engine is mounted on the port and one on the starboard side of the dredge, the hauling winches being manufactured by Williamson Bros., of Philadelphia. Steering is by four balanced rudders operated by an S. J. Gardner steam steering gear.

The auxiliaries are very complete, including two Blake & Knowles horizontal duplex 8-inch by 4-inch by 10-inch feed pumps, a horizontal simplex 8-inch by 14-inch by 12-inch air pump of the same make, and a centrifugal circulating pump, driven by a 6-inch by 6-inch simple engine direct connected. A 12-inch centrifugal jet pump driven by a Kerr turbine of 142 brake horsepower running at 1,650 revolutions per minute is installed, producing a pressure of 34 pounds on nozzles in the suction head. The auxiliaries also include a Reilly multicoil heater in both the boiler and engine rooms, a Griscom-Russell 3-inch grease extractor, Lynn-Superior filters and a Schutte-Koerting film heater for the hot water line. Fischer pump governors are installed and the discharge lines are fitted with pop safety valves discharging back into the suction.

The electric plant consists of a 15-kilowatt, direct connected, Kerr turbine-driven generator, operating at 3,600 revolutions per minute, which supplies power for lighting and a number of machine tools. The refrigerating plant was supplied by the York Manufacturing Company, York, Pa., and has a capacity of one ton of ice per 24 hours.

On trials the main propelling engines developed a maximum of 1,175 indicated horsepower with cut-off at seven-sixteenths of the stroke.

Recent Ellicott Pipe Line and Sea-Going Hydraulic Dredges

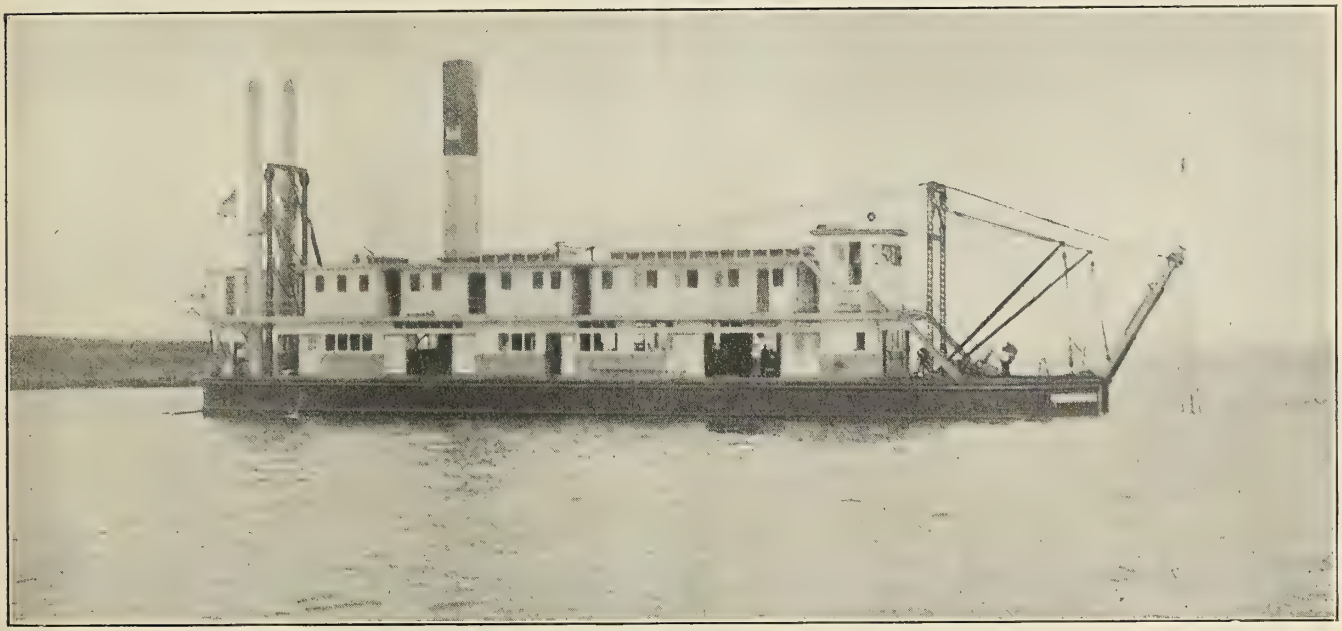
The output of the Ellicott Machine Corporation, Baltimore, Md., for 1914, included a number of interesting pipe line and sea-going dredges. Two 20-inch steel hull pipe-line dredges were built which were duplicates in every respect. One of these, the *Currituck,* is illustrated on this page.

These dredges are of the cutter type, with a single sand-pumping outfit. The pumping machinery consists of a centrifugal pump directly connected to a triple expansion fore and aft engine. The cutter for loosening the material to be dredged is driven by a double condensing engine mounted on the ladder at its inboard end. The feeding into the cut is by means of wire rope haulage on each side of the bow, with pivoted stern, and the advance forward is accomplished by two spuds. The hauling drums are driven through a lay shaft and gearing by double reversible condensing engines.

Steam for operating the machinery is supplied at 200 pounds pressure by four Scotch boilers. The aggregate indicated horsepower of the machinery under ordinary service conditions is about 1,000 and the capacity of the dredge 750 cubic yards per hour place measurement. The hull of the dredge is 150 feet long overall, 40 feet molded beam and 10 feet 6 inches extreme depth.

This company also built during 1914 the United States sea-going dredge *Absecon,* now at work improving Absecon Inlet, N. J. This dredge is about 160 feet long over all, 35 feet beam, 12 feet deep, and will carry in her hoppers about 300 yards of sand.

The *Absecon* is built on the Isherwood system with side dump doors, hydraulically operated. She has two Almy, Class E, watertube boilers, designed for 250 pounds working pressure. She is a twin screw boat propelled by two compound condensing engines with cylinders 12 and 24 inches diameter by 18 inches stroke, designed for 120 revolutions per minute. The pumping outfit consists of a 16-inch sand pump driven by a compound engine with cylinders 12 inches by 24 inches diameter by 14 inches stroke. There is a full equipment of electric lights, steam steering



20-Inch Pipe Line Dredge *Currituck*, Built by the Ellicott Machine Corporation

Fig. 1.—Powerful Dipper Dredge *Gamboa*, Built by the Bucyrus Company, at work in the Culebra Cut on the Panama Canal

gear and auxiliaries, making the dredge a completely equipped sea-going vessel.

Another sea-going dredge which the Ellicott Machine Corporation has just completed for government service in the Galveston, Tex., district, is the *Comstock*, 165 feet long overall, 35 feet beam, molded, and 17 feet depth with a capacity for 500 cubic yards of sand on a 14-foot 6-inch draft. She is a single screw boat propelled by a compound engine with cylinders 18 and 36 inches diameter by 24 inches stroke, supplied with steam by two Scotch boilers equipped for burning oil and fitted with Eckliff circulators.

The pumping machinery consists of two 12-inch by 24-inch by 14-inch compound engines which drive two 15-inch dredging pumps. The condensing plant is independent of the main engines and has 1,700 square feet of cooling surface. The dredge is equipped with steam steering gear, an electric light plant, evaporating plant, and an ice-making plant, and has very commodious quarters for the officers and crew.

The Most Powerful Dipper Dredge in the World

The two 15-yard dipper dredges *Gamboa* and *Paraiso*, built for service on the Panama Canal by the Bucyrus Company, South Milwaukee, Wis., and described in detail in our May, 1913, issue, exceed in both size and power any other dredges of the same type that have ever been built. They have proved their value in working under severe conditions in the Culebra Cut, fighting the slides which have so frequently menaced navigation since the canal was opened.

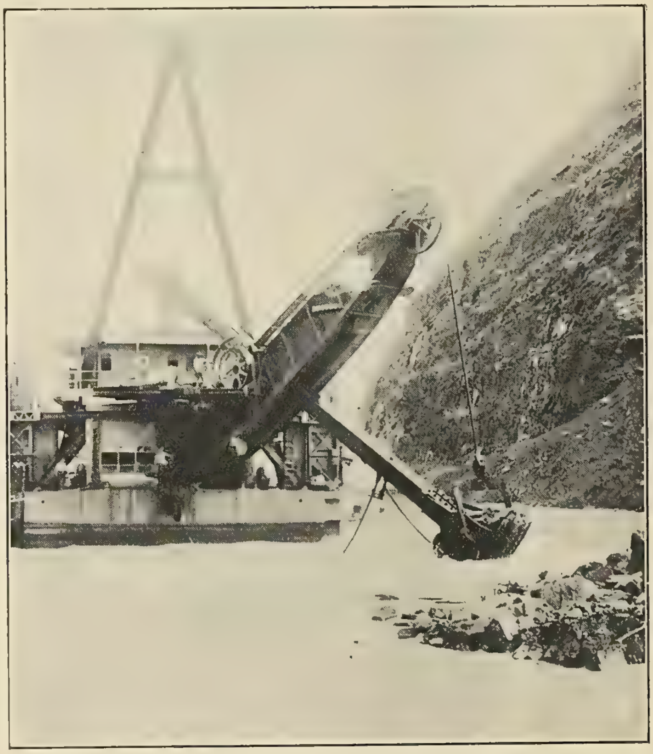


Fig. 2.—The *Paraiso* Fighting the Curcuracha Slide in Culebra Cut

Ever since the dredges started work, they have been in the heaviest kind of digging, consisting of an outcropping dyke of trap, which is unusually hard, metallic rock. An idea of the difficulty of this digging can be gained from the fact that during a thirty-day test of the *Paraiso* a day did not pass that the dredge did not dig up from half a dozen to two dozen boulders weighing from 10 to 30 tons apiece; of such size, in fact, that they had to be blasted on the dipper before being placed on the scows. The largest boulder encountered so far weighed about 50 tons. When the dredges were first put in operation their speed was set at from 90 to 120 seconds per cycle. Within a week the dredges were speeded up gradually until, when they were turned over to the dredging division, 45 seconds per cycle was attained and set as normal. This was while digging to a depth of 40 to 50 feet.

The output of the dredges has likewise been gradually increasing. The average of 3,000 to 5,000 cubic yards per day of 16 hours first obtained has been increased to an average of 9,000 to 10,000 cubic yards. The monthly output has also been increasing. The official figures for the *Paraiso* from June to November, 1914, are as follows: June, 72,700 cubic yards; July, 84,700 cubic yards; August, 96,400 cubic yards; September, 109,800 cubic yards; October, 125,000 cubic yards, and November, 140,000 cubic yards.

Both dredges have used their 10-yard rock dippers for this work, and they are designed to dig to a depth of 50 feet below the surface of the water.

The dredges are duplicates, except in a few minor details. The main hoisting machinery consists of horizontal, twin tandem, compound, condensing engines, compound geared to heavy spur gears mounted on the main hoisting shaft which carries the drums. The drum is of the differential type which is characteristic of high-powered Bucyrus dredges. The shape permits the maximum digging force and the slowest speed at the time when the dipper is digging and the angle between the hoisting rope and the dipper handle is the sharpest. As the dipper is hoisted the rope winds on to the large diameter of the drum, which of course increases the speed when this is most desirable and when the maximum bail pull is not required.

10-Yard Dipper Dredges on the Cape Cod Canal

The Cape Cod Canal is now an accomplished fact and has been described before, but to refresh the memory of some we may repeat that it is 8 miles long and has a designed width of 100 feet on the bottom, and a depth of 25 feet. As in the Panama Canal, dry excavation was employed to take off the material above the waterline and hydraulic and other dredges were employed to some extent in deepening the entrances. For the main driving of the heading from each end, two powerful dipper dredges, the *Governor Herrick* and *General Warfield*, were employed, one of which is shown in Fig. 2 and a detail view of the boom in Fig. 1.

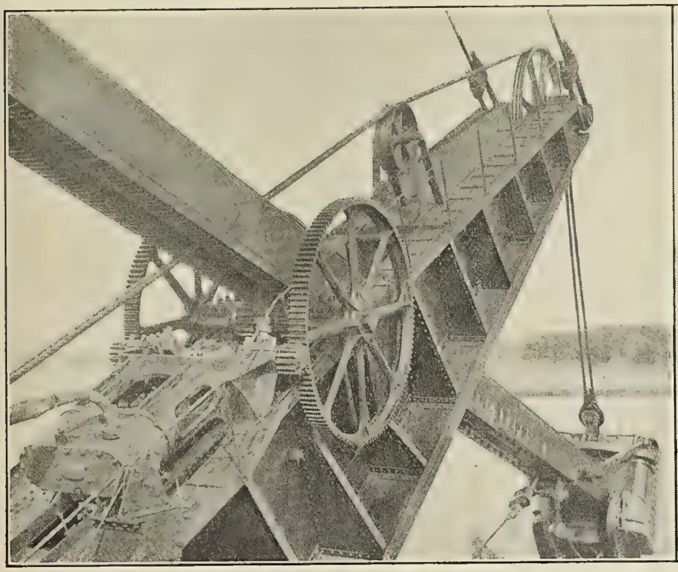


Fig. 1.—Detail of Boom of Ten-Yard Dipper Dredge

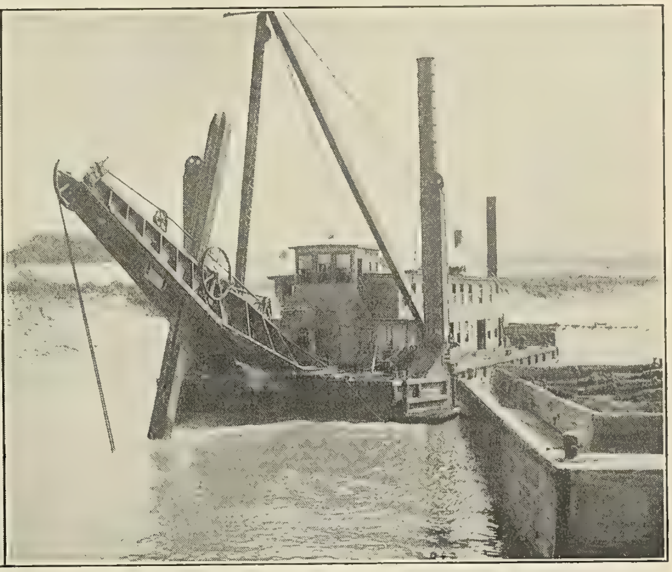


Fig. 2.—Dipper Dredge *Governor Herrick* in Operation on the Cape Cod Canal

Although the material to be excavated was of a sandy and earthy nature on top and in the entrances, the bulk of the channel beneath the surface was more difficult and contained much glacial drift and boulders. For this class of work, undoubtedly, the choice of the dipper type of dredge was a wise one. Not only could the dipper dredge do more effective work in such material than any other type, but it is eminently suitable for driving the heading and to dig its own flotation with a high bank ahead. Indeed, it may be doubted if any other type of dredge could do the work at all. A dredge of the hydraulic type could not handle the boulders, nor was any place of deposit available, and the bucket-ladder type would also have difficulty with the boulders and of working effectively in such a confined space.

All the material was loaded into barges and dumped at sea. The barges used contained 1,000 cubic yards each. By shifting the dredge from one side of the cut to the other when moving up, sufficient space was excavated ahead to permit the barge to come alongside, on either side alternately, and by passing the barge around the stern of the dredge both ends of it could be loaded.

The dredges are alike, and are of the following dimensions: Length of hull, 130 feet; beam, 42 feet; depth, 12 feet; size of main engines, 18 inches by 24 inches; size of swinging engines, 10 inches by 14 inches; depth to which dredge can work, 40 feet; type of boilers, Scotch marine; diameter of boilers, 9 feet 8 inches; length of boilers, 10 feet 6 inches; number of boilers, 2.

The hull is of steel with square bilges, strongly reinforced where necessary at front end and in way of spuds. It is stiffened longitudinally by two fore and aft trusses of depth to main deck. These with the strength of sides are ample for all purposes, so that the structural strength is contained entirely within the body of the hull. There are no deep trusses above deck as are frequently used in the older type of dipper dredge, and which are a survival from the days of wooden hulls and a crane-post.

The forward spuds are of steel and are operated by independent engines. There are two stern spuds mounted as oscillating or trailing spuds, also worked by separate engine. The boom, as will be seen, is of the well-known Robinson patent "Atlantic type," with straight members and solid turntable. It is fitted with a pair of reversible engines geared to the shipper shaft, to give a power feed to the dipper. This was introduced to give better maneuvering power when handling boulders, and to spot the dipper when dumping into barges at varying range, two conditions that were especially encountered on the Cape Cod Canal work.

The main engines and hoisting machinery are of very substantial design, all the gearing being of steel and the first motion gears machine-cut. The hoisting drum is conical, fitted with Robinson's system of double parallel hoisting ropes for a direct pull of 200,000 pounds. The band friction is steam operated and of exceptionally large bearing surface, being 18 inches wide, thus insuring durability and cool running. Special attention is paid to ease of handling without manual effort, all the motions being controlled by steam cylinders, with floating levers and compensating links, so that the movement of the piston corresponds to the movement of the hand. The main throttle is also of the balanced type, so that the engines, notwithstanding their great pull of 200,000 pounds, are extremely sensitive and quick and respond instantly to the levers. A speed of 30 to 40 seconds per dipper load can be made under favorable circumstances.

For handling the barges, two independent deck winches are fitted, each with three drums for wire rope lines. Suitable fair-leads are disposed about the deck so that the barges may be moved or held in position as required.

Comfortable crew quarters are fitted on the upper deck with every convenience, including electric light, and, altogether, these are two of the best equipped dipper dredges along the coast.

The work done by these two dredges was very satisfactory. Working three eight-hour shifts per day, the *General Warfield* has averaged nearly 100,000 cubic yards per month. In hard material and boulders the output would be somewhat less. In June and July, 1913, the *Governor Herrick* made a record of 251,000 cubic yards. The best month was 131,000 cubic yards and the best ten days 60,000 cubic yards.

These dredges were built by the American Locomotive Company under the designs and patents of A. W. Robinson, M. Inst. C. E.

Fig. 1.—Forty-Two-Inch Hydraulic Dredge *Foyers* at Bengal Waterways, India

42-Inch Hydraulic Dredge Foyers

The remarkable hydraulic dredge illustrated in Figs. 1 and 2 is in use in the inland navigation channels of Bengal, India. These river channels are very numerous and extensive, especially in the deltaic region of the Ganges. There are about 4,000 miles of inland waterways in Bengal navigable for steamers of a fairly large class. Many of these waterways are tidal for a considerable distance from the sea, and although they are beyond the reach of the sandy alluvium of the Ganges proper, they are obstructed in places by dense mud shoals and banks, which only require a moderate length of dredging to render good navigation of a fairly permanent character. To meet this condition the hydraulic dredge *Foyers* was built and put in service.

The *Foyers* was designed to be of the largest possible capacity that could navigate the rivers, and to be self-propelling so that it could readily go from place to place. There are two pumps, each with 30-inch inlet and outlet, connected to four suction pipes 24 inches in diameter, and one discharge pipe 42 inches in diameter. The distinguishing feature of this dredge is that it has been de-

signed for a straight forward feed to cut a channel in stiff clay or mud the full size of the section of the hull to permit its passage. For this purpose a battery of four cutters of special design for forward feed is mounted in two wells in front, the vessel being formed with three bows, as shown in illustration. The forward feed is accomplished by two wire rope anchorages set out ahead and connected to winding engines. The capacity is so great that a channel large enough to pass the dredge can be excavated at the rate of 200 to 300 lineal feet advance per hour. Special provision is made for the disposal of the spoil ashore by a shore pipe suspended from a terminal pontoon. This is towed astern by a short length of floating pipe in flexible sections.

These two pumps are driven by two sets of triple expansion engines of marine type having cylinders 17 inches by 27 inches by 46 inches diameter by 24-inch stroke. The boilers are of Babcock & Wilcox marine type and four in number. The vessel is propelled by triple screws.

The four cutters are driven by two sets of horizontal compound engines, placed on forward deck through the medium of gearing so arranged as to permit the cutters to rise and fall. The cutters are of propeller form with blades specially shaped to give proper clearance angle and a drawing cut.

All the movements of the dredge are controlled from a pilot house on the upper deck. The operation of the dredge is very simple.

This dredge was designed by A. W. Robinson, of Montreal, to the requirements of Mr. O. C. Lees, Superintending Engineer of the Department of Public Works in Bengal.

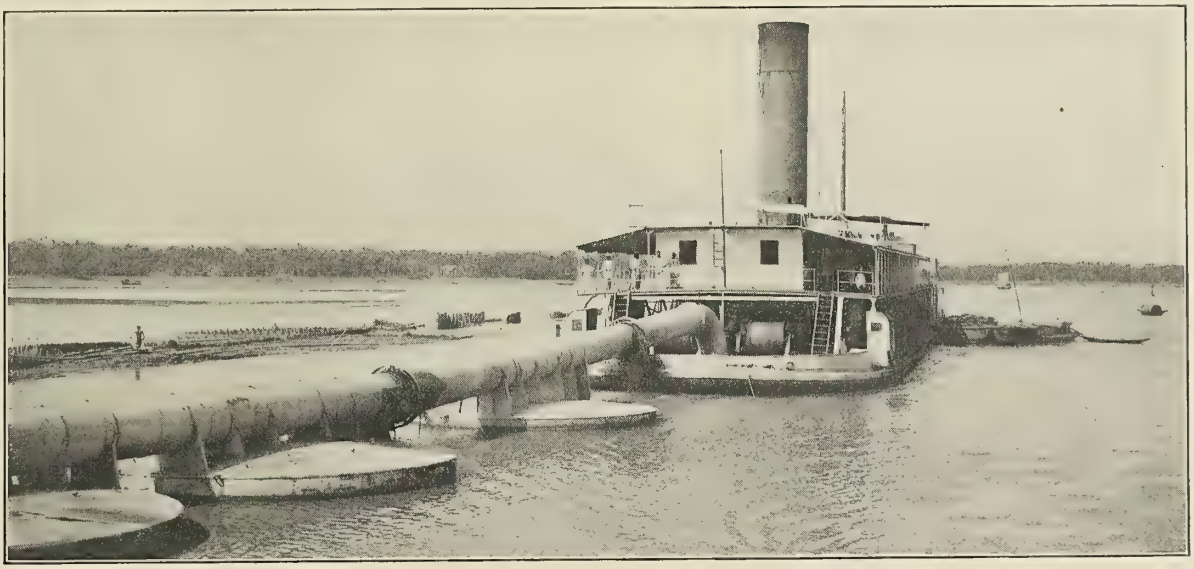


Fig. 2.—Stern View of the *Foyers*, Showing Semi-Circular Stern

Quick Repairs to Damaged Dredge

Two government vessels, the U. S. Quartermaster steamer *General S. B. Holabird* and the U. S. Engineers' Department dredge *Wahalak,* collided recently in Mobile Bay while the *Holabird* was bound to Fort Morgan, and the dredge, in tow of two government tugs, was bound to Mobile to commence work on the ship channel in Mobile River above the city. The *Wahalak* was hauled out on the Gulf Dry Docks Company's ways in a leaking condition, but the *Holabird* was not damaged, as the collision was head-on.

Bids for repairing the dredge were received from the different repair shops in Mobile. The lowest bid was from the Home Industry Iron Works, amounting to $3,900 (£800), and the job was finished in forty-eight hours. It is surmised that the cause of the collision was that the *Holabird* struck shallow water, which caused her to sheer.

L. E. G.

Fig. 1.—Quartermaster Steamer *Gen. S. B. Holabird*

Fig. 2.—Dredge *Wahalak* in Dry Dock

Notes on the Conversion of Cargo Vessels into Bulk Oil Carriers—III

BY F. K. RUPRECHT *

The tank deck will form the top of the pump rooms, if they are located in the cofferdams. A trunk will pass through this deck for access to the pump rooms, and the connection of trunk to deck must be made oiltight. Since the pump rooms are on only one side of the vessel, that portion between the shell and the centerline bulkhead on the one side only need be made oiltight. On the other side the original deck will be left between the ship's side and the expansion trunk bulkhead, but that portion between the trunk bulkhead and the centerline bulkhead will be removed except that the above-mentioned shelves will remain on the centerline and transverse bulkheads. The portion between the shell and the expansion must have large drainage holes cut in it. In the forward and after cofferdams the entire deck will be removed, as it interferes greatly with the ventilation unless many large openings are cut, which would prove to be expensive and dangerous to the crew.

Upper Deck

The upper deck will be oiltight over the expansion trunk and cofferdam only unless the spaces alongside of the trunk bulkheads are used as summer tanks. In this case the deck will have to be oiltight throughout the cargo and cofferdam spaces. The deck beams will be cut at the expansion trunk bulkheads and bracketed to them. They will also be cut and bracketed to the centerline bulkhead.

This deck, as a rule, is the strength deck, and only shelter or awning decks are fitted above it. All the oiltight hatches will be fitted on this deck except in a shelter deck vessel where the summer tank hatches will be on that deck. Ample compensation must be made for the openings cut for the hatches, and it will be found cheaper to do this by fitting heavy plates between ¾ inch and 1 inch thick instead of trying to fit oiltight doublings on the old deck plates. The old cargo hatches will have to be plated over by fitting new beams between the trunk bulkheads and the centerline, or as required to take the deck plating In view of this new plating required, and the heavy plating for compensation, it will be found advisable to fit an entirely new deck over the expansion trunks. A narrow, heavy plate will be fitted to take the upper angles of the centerline bulkhead, and a heavy plate will take the hatch coaming bounding angles. All plates will have double riveted laps and butts, except the heavy compensation plates, which will be fitted with single butt and edge straps on the top side. The other plating will be of the ordinary weight required by the rules.

If the 'tween decks are used as coal bunkers, the old plating between the trunk bulkheads and the shell can remain intact, but hatches will be fitted for access to bunkers and for trimming purposes. If, however, oil is to be carried in some of this space, the frames will have to be cut at the deck and a flanged plate or angle fitted in the same manner as on the tank deck. If the vessel is a two-deck vessel, this connection to the shell is all ready tight. Hatches for the summer tanks will also be cut in this deck and heavy compensation plates must also be fitted as around the other oil hatches.

The cofferdams will extend up to this deck for the entire width of the vessel, and so the plating must be worked oiltight over them and for a few frame spaces forward and aft of the bulkhead forming them. In any vessel where this deck is not the watertight weather deck the frames will be cut and flanged plates fitted to shell and deck as on the tank deck.

Pump Room Construction

As stated before, the best location for the pump rooms is in the large cofferdams forward and aft of the engines and boilers. This simplifies the construction and insures a dry pump room. There are two types of construction that can be used—i. e., the suspended floor or that with the pumping flat built on the floor plates.

In the suspended type we keep the sea valves outside of the pump rooms and use less space. In this type the floor is built at any desired height and consists of strakes of plating of the same weight as the lowest bulkhead plating, connected to the centerline and one of the transverse bulkheads by two small single riveted or one large double riveted angle. The plates are cut out in way of the frames, and the angle or angles connecting the flat to the shell are stapled around them. Brackets are fitted from the frames to the flat top and bottom, being double clipped, single riveted or single clipped with double zigzag riveting to top, and connected to transverse stiffeners in line with the frames on the bottom. These stiffeners will be the same kind and size as the verticals on the bulkheads, and will be bracketed to the centerline bulkhead. If the vertical stiffeners on this bulkhead come on the pump room side, they are best cut in way of the flat and the angles fitted continuously. In this case the stiffeners will be bracketed top and bottom to the flat and transverse stiffeners respectively. It will, however, usually be possible to arrange the pump room and stiffeners on alternate sides of the centerline bulkhead. The same applies to the transverse bulkhead which forms the other side of the pump room, for the construction is simplified by fitting the vertical stiffeners outside the pump room. In this case only the horizontal bulkhead stiffeners are in the pump room, and these involve no extra consideration because of their location.

The horizontal stiffeners on the centerline bulkhead will be cut at and bracketed to the bulkhead which forms the third side of the pump room, instead of being carried through and bracketed to the cofferdam bulkhead. This former bulkhead will be of the same construction as the other transverse bulkheads, but will extend only to the pump room flat, to which it will be connected by a large double riveted angle. The vertical stiffeners will be on the inside and bracketed by brackets and double clips single riveted or single clips double riveted to the flat. Horizontal webs will be carried at the stringer levels from the pump room bulkhead to the cofferdam bulkhead at the centerline bulkhead and at the shell.

Since this is the cofferdam space, these webs will have large lightening holes cut in them for drainage and access. On the cofferdam bulkhead the vertical stiffeners will, as a rule, be placed on the opposite side from the horizontal webs, but if necessary the latter may be run intercostal. Stanchions will be fitted under the pump room from the transverse flat stiffeners to the strips of plating on keelson or to the floor plates. The pump foundations will consist of angles and plates to suit the work as designed.

The tank deck will form the top of the pump room and a trunk will pass through this deck to give access and light and air. This trunk may be arranged so that one side is formed by the shell, in which case only three sides need be built, or an ordinary four-sided trunk can be installed in a suitable location. The size should be ample for access and should have a bolted flat top which can be re-

* Associate Member Society of Naval Architects and Marine Engineers.

moved for the purpose of taking out the old pumps and installing new ones or parts. The trunk will be oiltight to a height of about 18 inches above the upper deck and watertight the rest of the height. Skylights and ventilators will be fitted on the top plate, all of which should be capable of being closed watertight. One ventilator should be carried down to about 6 feet above the flat to act as a downtake for fresh air, and the other will act as an exhaust.

A watertight door will be fitted at the weather deck. If desired, in a shelter deck vessel another door may be added in the shelter 'tween deck.

If the pump room flat is to be laid at the tank top level a complete bulkhead will have to be built. This will involve the removing of a floor plate and adding of much extra weight of material. In this case the flat need not be oiltight and can be made of portable sections of checkered plate.

If the pump room is situated in one of the cargo tanks the flat will have to be laid upon the floor plates because of the sea valves. This type also involves a complete extra bulkhead, but the expansion trunk may be used as the access trunk. An entrance with bolted top plate skylights and ventilators will be fitted on the weather deck.

Cofferdams

As already stated, the foremost and the aftermost cofferdams will be two frame spaces in length, and the amidship ones forward and aft of the machinery spaces will be five or six frame spaces to allow room for a pump room in each. (See Figs. 3 and 4, May issue.)

The cofferdam bulkheads will be of the same construction as the cargo transverse bulkheads, but the stiffeners will be arranged on the side most suitable. The bulkheads of the former cofferdams will have the vertical stiffeners on the inside and the brackets at the bottom will be clipped to the bottom plating and the floor plate of the intermediate frame. The best way is to remove this intermediate floor plate and carry flanged brackets between the bulkheads double riveted to the vertical stiffeners and clipped to the bottom shell plating. The shell rivet holes of the intermediate frame must be plugged with rivets which will be chipped flush in way of the bracket clips.

Other flanged brackets will be fitted between the two bulkheads as called for by Lloyd's. The bulkheads will be continuous from bottom plating to the upper deck. The stringers will be cut at the bulkheads and a solid rectangular bracket will be carried from bulkhead to bulkhead. This bracket will be the same width as the stringer brackets to the other bulkheads and clipped and riveted in a similar manner.

The bulkheads of the amidship cofferdams will have their vertical stiffeners on the outside, and no bulkhead to bulkhead brackets will be fitted. The stringer and horizontal stiffener brackets will be of the same type as in the cargo tanks.

Centerline Bulkheads

The longitudinal centerline bulkhead will be continuous and oiltight throughout the tanks and cofferdams. It will extend from the top of the centerline keelson to the top of the expansion trunk. To avoid any abrupt decrease of strength, this bulkhead will be ended with buttresses in the forward dry hold, cross bunkers, engine room and the after dry hold. In the engine room a special arrangement must be made because it would be impossible in most cases to fit a large buttress in this space. In one case the engine room bulkhead was specially stiffened but no buttress was fitted, and this will be the usual method.

The size of these buttresses will be taken from the rules of the registration societies. The weight of bulkhead plating and the size of the stiffeners will be in accordance to rule, and the only place that we cannot apply these rules will be in way of the double bottom. The centerline keelson in most vessels is watertight, and by putting extra rivets in the angle connections to the tank top and to the keel plate it can be made oiltight. The bulkhead will then be built on the strip of tank top plating remaining at the centerline.

It is advisable to place this bulkhead about 8 to 10 inches off center to keep the bulkhead angles clear of the keelson angles. This avoids cutting out rivets and insures tight work. (See Fig. 8.) Forward the offset will be measured on one side of the centerline and aft on the other so that the structural weights will balance. If the keelson is not tight it will be removed and the bulkhead will be built on the centerline from keel plate to expansion trunk.

(To be continued.)

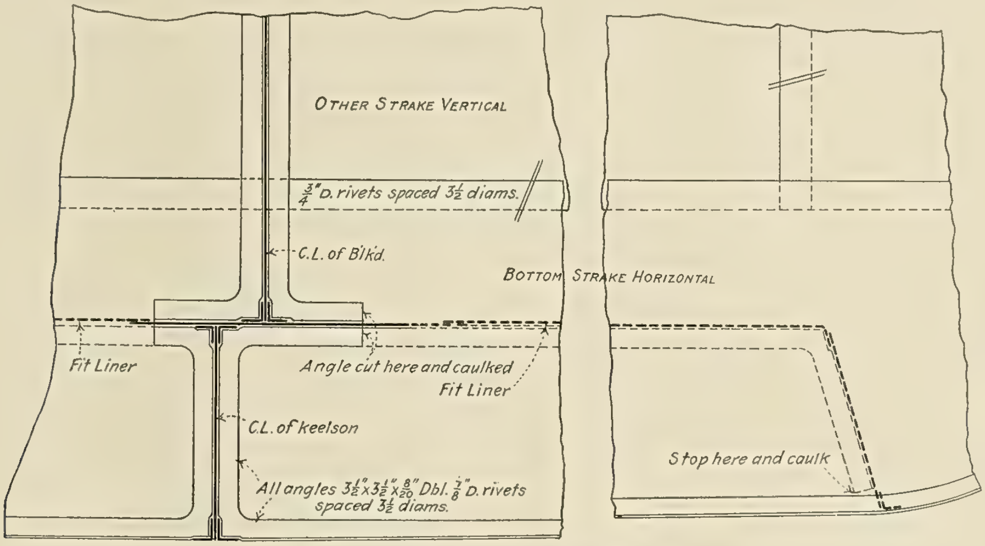


Fig. 8.—Centerline Bulkhead Placed Off Center

Davits and the New Requirements

Rules for Boat Davits in the Seaman's Act—How Various Types of Davits Meet These Requirements

BY HARRY W. BROADY *

Through the passing of new laws in this country and abroad, the davit question has become a very serious problem for shipowners to solve. The International Conference on Safety at Sea, in London, 1913, decided that mechanically operated davits should be required on board ships in the future. The time for the new requirements to go into effect is stated as immediately for all new ships, the keels of which are laid after December 31, 1914, and for existing ships not later than July 1, 1915.

The rules recommended by the London Conference are now enforced by all the big shipping nations. Last year the International rules were ratified by this country, but with such an amendment as to practically make the ratification of no value whatsoever.

The United States Board of Supervising Inspectors first specified mechanically operated davits on board ships in their rules of January, 1914. A very interesting feature in that ruling was that "The gear should make it possible for one man at each davit to swing the boat out clear of the side." Nothing was mentioned about list of the ship. This new rule was never enforced on account of pending legislation, and it is now superseded by the Seaman's Act.

The rules in the Seaman's Act in regard to davits are as follows:

"1. The davits shall be of such strength that the boats can be lowered with their full complement of persons and equipment, the vessel being assumed to have a list of fifteen degrees.

"2. The davits must be fitted with a gear of sufficient power to insure that the boat can be turned out against the maximum list under which the lowering of boats is possible on the vessel in question."

There is also a rule providing for the approval of other appliances in lieu of davits. These other appliances have, so far, not been worked out to a practical solution, as compared with davits, and do not come within the scope of this article, and are therefore not covered in any way.

The first of the two rules is very clear and simple. The engineering problem involved in this rule is very easily solved, both theoretically and practically, which will be shown later on in this article. On the other hand, the second rule is very uncertain. What is meant by maximum list under which lowering of boats is possible is rather hard to decide. It is practically left open to the decision of the inspecting official in every case.

Shortly after the approval of the Seaman's Act, the writer had an opportunity to discuss this rule with several of the more interested persons in shipbuilding circles. They almost uniformly expressed the belief that this rule could not be enforced. The requirements could be so constructed as to enforce the use of davits suitable for lowering the lifeboats to *clear* the side of the ship when the ship is listed 15 degrees. This would necessitate davits with tremendous outreach because in their opinion the boats must be made to clear the side of the ship even at the waterline.

If this should be true, it would be necessary to have an arm about 22 to 25 feet long with an outreach of 16 to 18 feet for a 24-foot by 7-foot lifeboat, if the tumble-home was 20 inches and the boat deck 30 feet above the waterline. This certainly cannot be the intention of the law makers and will never be enforced by the sensible men who have power to decide in this matter.

A very good and commonly used practice is to give the lifeboat a 12-inch clearance from the ship's side at the

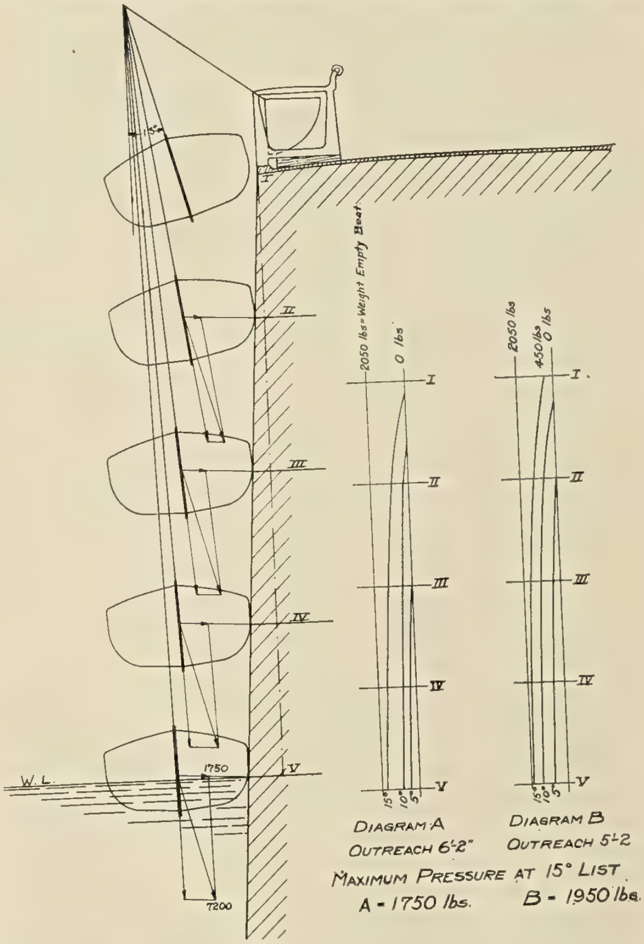


Fig. 1.—Diagram Showing Pressure of 24-Foot by 7-Foot Lifeboat Against Ship's Side. Weight of Lifeboat, 7,200 Pounds; Freeboard of Vessel, 30 Feet; Tumble-Home, 20 Inches

waterline, with the ship in an upright position and the davits fully swung out. The necessary outreach of the davits would then be equal to half the beam of the lifeboat, plus the tumble-home, plus 12 inches. If there is some larger obstruction like heavy fenders or guards on the ship's side in the way of the davits, the 12-inch clearance must be taken at that point.

If the inspecting official should now insist on lowering the fully loaded boat at, say, 15 degrees list of the ship, what would happen? Take, for example, as shown on Fig. 1, a 24-foot by 7-foot lifeboat with a carrying capacity of 30 persons. The tumble-home is 20 inches and the davits have accordingly an outreach of 3 feet 6 inches + 20 inches + 12 inches = 6 feet 2 inches. The distance from the boat deck to the waterline is 30 feet. The weight

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of boat and equipment and number of persons allowed, taken at 165 pounds per person, is 7,200 pounds. The pressure that the boat exerts on the ship's side under these conditions is shown in the accompanying diagram A, Fig. 1, for a list of 5 degrees, 10 degrees and 15 degrees. In none of the inclinations does this pressure amount to as much as the weight of the empty boat, which is 2,050 pounds. The pressure is even less than this weight when no clearance is provided between the boat and the ship's side at the waterline, instead of the 12 inches assumed above, the outreach, therefore being only 3 feet 6 inches + 20 inches = 5 feet 2 inches, as shown in Diagram B, Fig. 1. Any lifeboat is strong enough to support its own weight in any position it may rest—side, bilge, keel or upside down—and the pressure is then greater than it would be in any of the above-mentioned cases. The boat can therefore not be harmed when sliding down against the ship's side, as long as the pressure between the boat and the ship's side does not exceed the weight of the empty boat and as long as the lowering is done with reasonable care.

If there are sharp edges and obstructions, such as fenders, etc., sticking out from the ship's side, rubbing strakes ought to be provided in the way of the davits for the boats to slide on. More than 15 degrees list will probably never be required, as it is almost a physical impossibility to stand on a deck listed more than 15 degrees to turn davits and boat out. If the boat only clears the ship's side at the deck at, say, a list of 15 degrees, and the davits are of the proper kind, the shipowner need not be afraid of being able to launch the boat and of fully meeting the requirements for moving the boat against a list into position ready for launching.

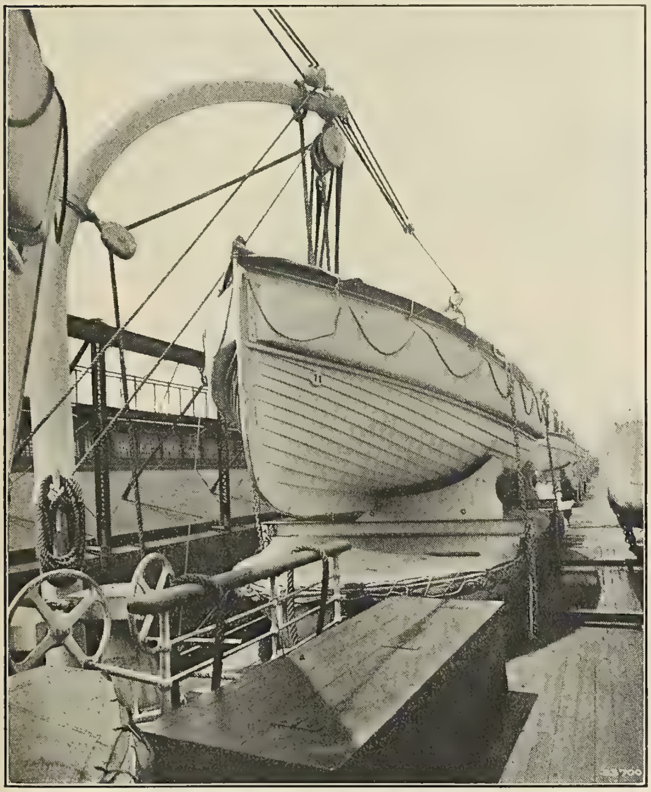

Fig. 2.—Installation of Round-Bar Davits with Turning Gear

The all-important question for a shipowner is, what kind of a davit will fully comply with the above rules? There are thousands of different types of davits and davit schemes, most of them patented. Very few of them have really been worked out practically and actually tried out on board ships. Almost all davits can be properly placed in some one of the different classes below:

Class A—Round-bar davits, working in a horizontal plane.

Class B—Round-bar davits with turning gear, working in the horizontal plane.

Class C—Trolley and track davits, working in the horizontal plane.

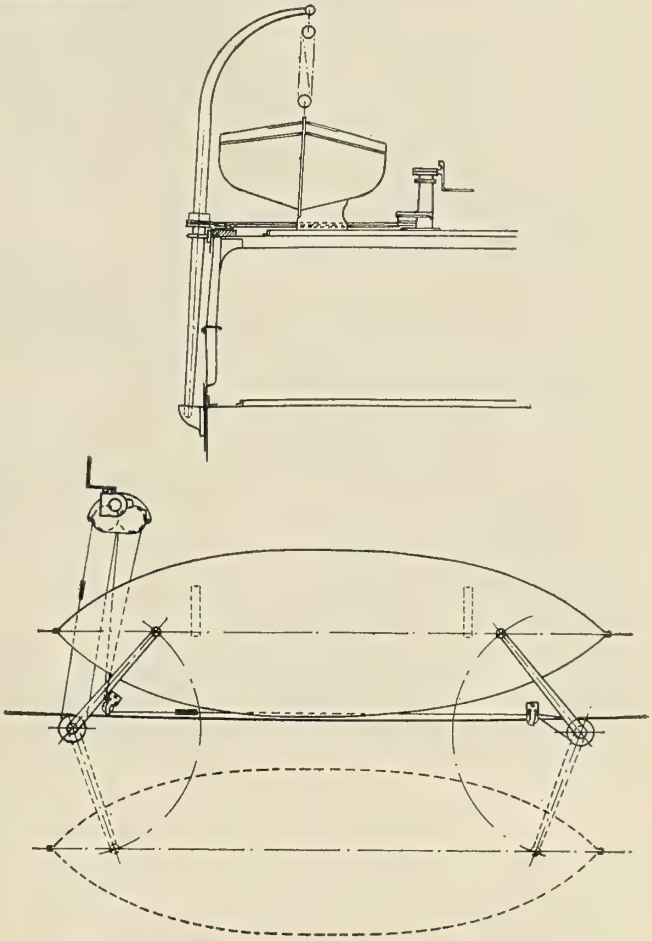

Fig. 3.—Welin Planet Gear for Turning Round-Bar Davits

Class D—Pivoted davits, working in the vertical plane, pivoted at one point.

Class E—Quadrant davits, working in the vertical plane, with moving fulcrum.

Class A Davits

Round-bar davits, Class A, could be made to comply with the first rule for the strength of davits, but never with the second rule for turning davits out against list. The boat must be pushed out, if it is going to be launched under a set of round-bar davits. This can perhaps be done when the ship is on an even keel, but as soon as there is a list, there will be a resistance against pushing the boat. This resistance will increase very rapidly with an increasing list and will make it impossible for the available men, even at a small list, to launch the boat. All the disadvantages of this class of davits are so well known that it is not necessary to go into further details about them, as these davits will not comply with the new law.

The discarding of this class of davits will naturally increase the safety on board ships, and this is what the law makers have been aiming at. Most of the ships nowadays are equipped with round-bar davits and will therefore have to be provided with mechanical davits. In such a case the shipowner will naturally try to find a turning gear that can be attached to his round-bar davits so that

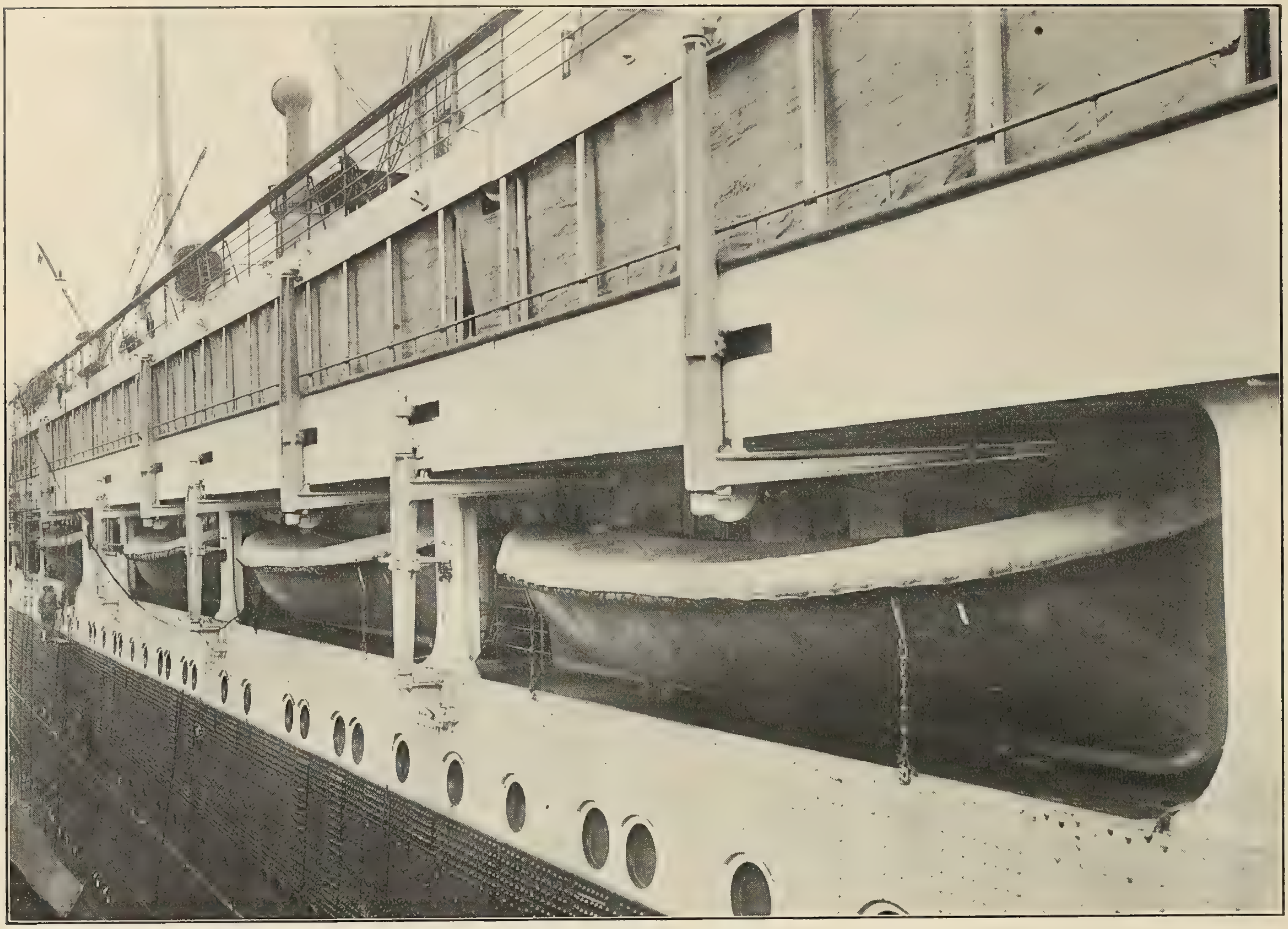

Fig. 4.—Davits for Handling Boats on Lower Decks. Installation on Hamburg-American Liner *Imperator*

they will comply with the new law. There are some very important things to be considered before such a change is made. These considerations are taken up under Class B, following.

Class B Davits

Round-bar davits with turning gear, Class B, are now installed on board several foreign ships and may be said to work with more or less success. They have been approved by the proper authorities as complying with the above rules, and an actual installation is shown in Fig. 2.

A davit of this kind consists of a round-bar arm swinging in bearing brackets and a gear arrangement secured rigidly to the ship. Owing to the necessity of large clearances in the bearings, to avoid sticking of the davits due to rust, and the deflection due to the suspended weight, the centerline of the vertical part of the arm will not be in the same position when swung outboard as when inboard. The deflection will, of course, increase with the weight and the list. It is therefore very clear to see that it will be impossible to get a good meshing in all positions between a gear on the vertical portion of the arm and the one in the part fixed to the deck. It is therefore impossible to use a worm gear drive directly on the davit arm. It is very desirable in order to control the turning properly to use a worm gear drive, as this can be made self-locking. To do this it is necessary to use spur gears between this drive and the davit arm. Even with this arrangement satisfactory results are very hard to obtain and cannot be recommended, as it is impossible to insure efficient working of the whole mechanism.

A very satisfactory solution is the Welin planet gear, patented in Great Britain. In this gear attachment all the troubles have been overcome by making the connection between the gear drive and the davit arms very flexible. The installation plan of such a gear is shown in Fig. 3. The arrangement for one set of davits consists of one deck standard containing the worm gear drive which through a pinion drives two drums. By means of a connecting link and partly toothed drums, the turning of the davits to swing out the boat will be exactly the same as the motion of the drums. The two drums are connected, one to each arm, by means of flexible wire rope. The grooved sheaves on the arms can be clamped on without the arms being taken out. The deflection of the arms and clearance in the bearing brackets will, in this case, not have the slightest effect on the efficiency of the gear. It will work just as well under all conditions. The planet gears have been installed on board several large ocean liners and work very satisfactorily.

The most important question for the shipowner to consider after he has found out that there are workable gear attachments to be had, is: Will it pay to install turning gear for the round-bar davits?

Take first, as an example, that it is a question of providing gear attachments for round-bar davits on an existing ship. First of all, it is necessary to find out if the old davits are strong enough to comply with the first rule for the strength of davits. In most cases they will not be strong enough and new davits, probably with greater outreach, will have to be installed. The old rule only required the davits to be strong enough to take the loaded

boat with the ship on an even keel, and each person figured at 140 pounds. The new law requires the davits to be strong enough to take the loaded boat with the ship at 15 degrees list, and each person figured at 165 pounds. The difference of the stresses that the boats are subjected to in these two cases can easily be figured out, as will be shown later when the testing of davits is discussed. In most cases there is an increase of about 40 percent in the stresses.

If, now, it is also necessary to have a greater outreach, the stresses will be still further increased. This will necessitate the installation of new and heavier davits. The cost of the new round-bar davits plus the necessary gear attachment would be greater than for even the best mechanical davits. The weight of such an installation would also be considerably greater than other types of mechanical davits. This is further gone into under quadrant davits. It is therefore recommended that if new davits are necessary, all these should be of the best mechanical type. They would then be less expensive and also lighter and more efficient than the makeshift of round-bar davits and gear attachment.

The new law requires more lifeboats on most of the passenger ships. It will therefore be necessary to have more davits installed to take care of these extra lifeboats. Consideration should then be given to procuring the best type of davits and davits of the same make all over the ship. This will facilitate both the required boat drills and also the annual inspection.

A very interesting davit arrangement of this class is shown in Fig. 4, Welin Patent No. 1,094,617. This davit is specially designed for lower decks with one of the davit arms extending to the deck above and the other to the deck below, thus giving free room for the boat to swing out. It is provided with a turning gear.

Formula for Round-Bar Davits

The following formula will give the required diameter for round-bar davits, so as to fulfil the requirements of the first rule for the strength of davits:

$$D = \sqrt[3]{\frac{16\,W \times R \times (1 + a)}{\pi \times K}} \quad \ldots\ldots\ldots\ldots\ldots (1)$$

D = diameter of each davit arm in inches.
W = weight of boat with full complement of equipment and persons (figured at 165 pounds each), plus weight of tackle and blocks, all in pounds.
R = radius of overhang of davit arm in inches.
a = increase of W to take care of increase in stresses when ship is listed 15 degrees.
K = fiber stress allowed in pounds per square inch.

Example: 24-foot — 30-person lifeboat.
$W = 7325$, $R = 95$ inches, $a = .22$, $K = 12{,}000$.

$$D = \sqrt[3]{\frac{16 \times 7325 \times 95 \times (1 + .22)}{\pi \times 12{,}000}}$$

$$D = 7\tfrac{1}{8} \text{ inches.}$$

The following average values substituted in above formula (1) will give a very simple and handy equation for calculating the diameter of the davit arms:

$a = .25$ and $K = 12{,}000$.

$$D = .0812 \sqrt[3]{W \times R}. \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

If davits of structural steel are used, their dimensions must give the same strength as round-bar davits figured in accordance with above formula.

Gravity Davits

There are many davits working on the gravity principle. All of them could be placed in one of the classes, C, D and E. The characteristic feature of this type of davit is that the arms and the boat are swung out by means of the force of gravity due to their own weight when they are released. This can very easily be arranged for, even if the ship has a list, by designing the davits so that the vertical line through the center of gravity of the system of davit arms and boat is always to the outboard side of the pivoted point of the davit arms. The davits are easily recovered by means of a drum and rope or a block and tackle arrangement. They are generally very simple in their construction, as they do not require any gear or screw control; but they are also very unsafe, almost dangerous to handle, especially if the ship is rolling. The boat is not under satisfactory control, as a rolling ship can throw the center of gravity of the system inside the pivoted points of the arms, and the boat will

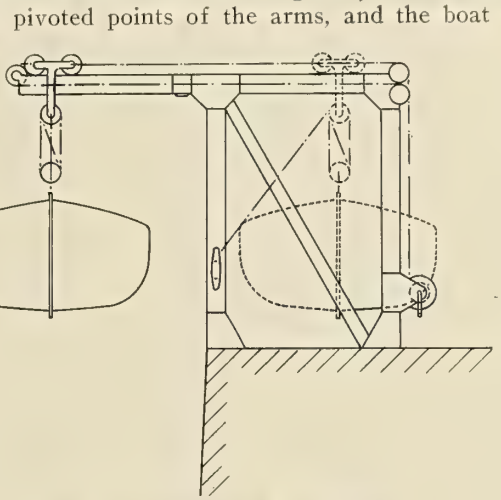

Fig. 5.—Trolley and Track Davit

then start to swing inboard again. It may also happen that the list is greater than the davits are designed for, thus making it impossible to launch the boat.

The wording of the rules seems to have excluded all davits of the gravity type, as it reads: "A gear fitted to davit." Therefore, as such davits, according to the wording, will not comply with the new law, they are not further considered in this article.

Class C Davits

Trolley and track davits, Class C, are very seldom used. Many patents have been issued for davits of this class, but very few have made further progress. The principle is theoretically the nearest to the ideal, as with such davits the figured power required to swing the boats out is less than for any other class of davits. All the friction to be overcome is rolling friction and no unnecessary lifting of the boat is done. A trolley and track davit arrangement is shown in Fig. 5.

The reason why this class of davits is not more universally used is: First, that they will necessarily be rather complicated at best. There must be folding or telescoping arms, reaching beyond the ship's side, when the boat is to be launched. These must be very securely locked and fastened in working position, so as to withstand the strain, if the ship is rolling or pitching. The folding arms must be held close to the ship's side, so as to be out of the way when not in use; they are sometimes made to slide in and out athwartship. The trolley arrangement necessary for taking the boat out must always be under control in all positions. This feature complicates the machinery considerably. The davit falls must be belayed in a suitable way, so that the boat is lifted as little as possible when swung out, thus minimizing the power required.

From the above statement it can be seen that not only

is the machinery complicated, but the operations necessary to launch a boat are increased to three, viz.: First, to secure the outboard arms in position; second, to turn the boat out, and third, to lower the boat. With all other davits only two operations are needed—i. e., to swing out the davits and lower the boat. Operations of clearing and loading the boat are, of course, the same for all types of davits.

The second reason why this class of davits is not generally used is that they must always be rather heavy and are also clumsy looking. This is of importance because everyone knows that the word "ship-shape" stands for "neat and pleasing to the eye." The heaviness and clumsiness are especially objectionable when the davits are placed on the boat deck. The structure must be very rigid and substantial, as all the many working parts are high above the deck, and the whole outfit will therefore be very top-heavy. In all other davits the working parts are in the lower portion close to the deck. Trolley and track davits are naturally made of structural steel, but this does not improve them in any way, and it will add to the cost of upkeep, as compared with davits made of forgings or cast steel.

The third reason for not using the trolley or track davits is the cost. Owing to the great number of working parts and controls necessary, and also the heavy construction, the cost will naturally be considerably higher than for any other class of davits—even the best.

Only in one case can this class be of any advantage whatsoever, and that is for lower deck installation. No structure is there needed, the track is fastened under the upper deck and the appearance, under these circumstances, is not so noticeable; also they would be lighter and cheaper. However, the general opinion is that it is not good policy to place lifeboats on lower decks and it is very seldom done. Therefore this application of the trolley and track davits is of minor importance.

(*To be concluded.*)

Application of Electricity to Propulsion*

BY WILLIAM T. DONNELLY †

The electric power equipment of the *Dawn* (described in the May issue) has answered every anticipation and requirement, and the author is now prepared to take up the work of the second and principal object of its construction; that is, the application of electric power to the propulsion of one or more boats from the electric power boat. This is primarily a problem of a floating electric power station distributing power over a very limited area and working under the most advantageous conditions, that is the very lowest cost of power production, a very small cost for power distribution and operating under a very high load factor.

It has already been demonstrated that an electric motor will drive a screw propeller, and through that a boat, equally as well as it will do any other kind of work, and I might add that there is already some reason to believe that the action of an electric motor driving a screw propeller will show somewhat higher efficiency than is obtainable by a reciprocating engine. This is believed to be due to the fact that the turning moment of an electric motor is constant, while the turning moment from any reciprocating form of engine is variable, and it is believed that water as a resisting medium is very sensitive to the variation in turning moment. As a partial confirmation of this I would refer you to a very recent paper on "The Electrical Equipment of the Collier *Jupiter*," by Lieut. S. M. Robinson, read before the last meeting of the American Society of Naval Architects and Marine Engineers, in which a remarkable propeller efficiency is claimed.

Electrically Propelled Cargo Barge.

Referring to Fig. 12, there will be seen the type of cargo barge to which the writer hopes to apply electric propulsion at an early date. This barge is designed to carry about 200 tons of cargo and is of such dimensions as to be driven at approximately five miles an hour by 35 horsepower, the amount which will be available from the power boat *Dawn*.

Referring to the power plant on the barge (Fig. 13), it will be noticed that the application, while not new, is rather unusual. The motor is placed on the deck and drives downwards through a hollow rudder stem, transmitting the power to the propeller shaft mounted in the rudder by means of bevel pinion and gear. The particular object of this method of applying power is to increase the maneuvering power of the barge. By turning the rudder it will be possible to steer the barge without headway. This application of power is more particularly adapted to harbor and canal use, where only a comparatively small amount of power will be applied. It should be noted that the rudder in this case will always be balanced, as the thrust in any position is directly against the rudder post. There will, however, be a certain amount of unbalanced condition, due to the transmission of power. This will have to be taken care of by the steering gear. In the cross section of this barge (Fig. 14) is indicated the amount of space that a cargo of cement would occupy. From this it is very evident that in some instances a blunt form of cargo boat, giving great cargo capacity, is of no advantage, for it is very plain that in this case there is a very great excess of cargo space, and this feature opens up a very real question as to the design of hulls for special cargoes.

Flexible Electric Conductor

The only question which seems to be open regarding the possibility of applying electricity broadly by this method to marine transportation is the one of the flexible electric conductor, connecting the vessels together. In this connection it is, of course, well understood that in towing at the present time, with more that one boat in tow, all the power must be transmitted by a stress between the tow boat and the first vessel of the tow, then the full stress for the remaining part of the tow through the next connecting line, and so on to the end of the tow. In deep-sea towing, where the surge of the vessel due to wave action creates a very great stress, it is necessary to take care of the intermittent stress by an automatic steam windlass giving out and taking in the line.

With the transmission of electric energy over a flexible conductor, there will be no stress whatever upon the line, and in harbor, river and canal work it would seem that there would be little or no difficulty in keeping the boats grouped together or properly spaced by the control of the power, it being understood that the distribution of the current to the motors propelling the different boats can be adjusted not only at the power boat but also at the controller on each of the boats to which power is delivered. This controller will be ready at the hand of the man at the wheel, so that power and steering are controllable at the same time. Of course there is no restriction to having a supplementary line for limiting the distance, thus relieving the conductor of all possible stress. It is also possible to provide an automatic reel which will take care of the slack and give out line due to a maximum stress.

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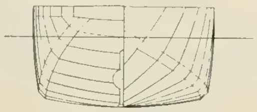
For towing at sea, it is entirely possible to have a supplementary line or wire hawser which will automatically be kept at a definite tension, and, if found necessary, the conductor can be reeled on this or a separately controlled drum.

I do not regard the maintaining of a waterproof flexible conductor as a difficult problem, it being, of course, understood that with one insulated conductor at the center of the cable surrounded by the other conductor, it would be entirely practical to use the cable with the outer wires exposed.



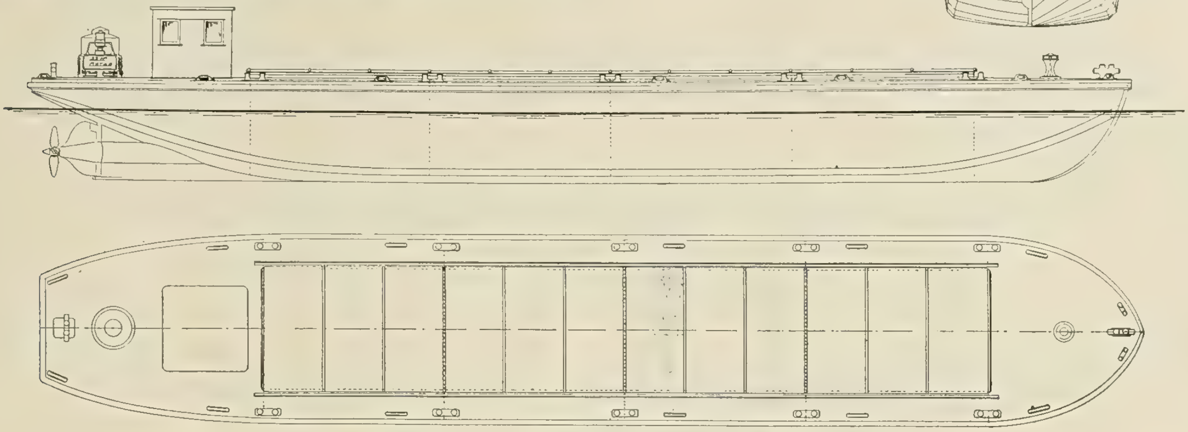


Fig. 12.—Design for Cargo Barge Equipped with Electric Drive

Regarding the cost of the electrical conductors, owing to the fact that towing is conducted at a slow rate of speed, the stress on the line for the transmission of power is comparatively high, and I have found that the probable cost of the electric conductor per unit of length will not be more than for the present towing lines for the same power transmission.

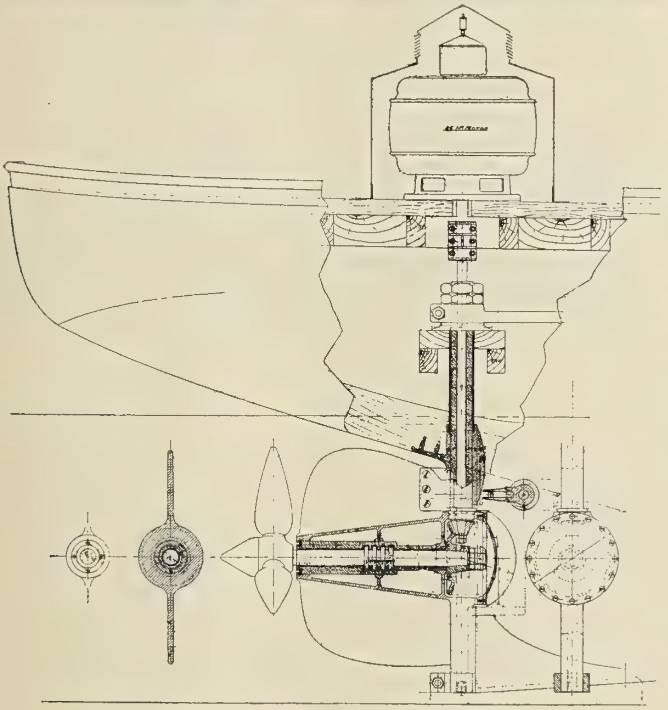


Fig. 13.—Power Plant of Cargo Barge

Granting the transfer of electricity from one vessel to another, there would seem to be left little or no difficulty to overcome; for it must be admitted that if an electric motor will drive one vessel, it will drive another, and the reliability of the electric motor has been so positively and clearly demonstrated in so many different applications that it is practically a foregone conclusion that it will uphold its reputation. It is not anticipated that this application of electricity will displace all other forms of propulsion, but it is firmly believed that it must have a very positive and broad application.

Broad Possibilities of Electric Propulsion

I wish now to point out in a general way a few of the broad possibilities resulting from the distribution of electricity on the water. It is perfectly plain from an engineering point of view that a very much better condition of things can be brought about if a vessel can be built for the generation of power only, and that a much better and safer passenger boat can be built if all questions of power generation and freight transportation can be eliminated. It is equally apparent that a vastly more suitable vessel can be provided for the transportation of freight of all kinds if the power plant can be eliminated with all its provisions as regards fuel, water, crew and stores.

An attempt was made in this direction when towing was adopted, but, as has been shown, the method of applying power by a tow boat is the very crudest possible form, whereas the application of electricity from one boat to another puts little or no restriction upon maneuvering power of either and provides for very great economy in power production. A cargo boat can be designed with

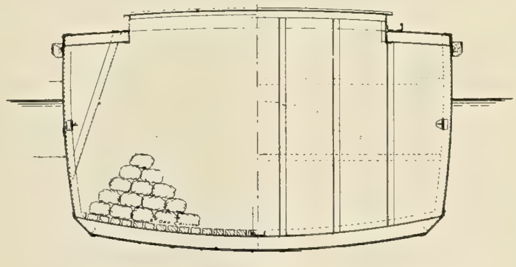


Fig. 14.—Midship Section of Cargo Barge

little or no restrictions for any particular kind of merchandise, and provided with every facility for loading and unloading. The only requirement, so far as transportation is concerned, is that it shall have an electric motor driving suitable propelling means to operate it at a pre-determined rate of speed. In this relation it should be stated that a transportation rate of about eleven miles an hour has been determined as the economic rate of cargo transportation

over long distances, and it would appear that there should be no difficulty in maintaining this rate with a considerable fleet of cargo vessels.

It should be understood that in the ordinary method of towing it is practically impossible to determine the amount of power used or transmitted, but with the use of electricity it is practical to record the power both on the power boat and upon the vessel propelled, and to establish a price per kilowatt hour. It is of course evident that the amount of power will vary with weather and tide conditions, but this does not detract from the very great desirability of knowing exactly what power is used. This would very

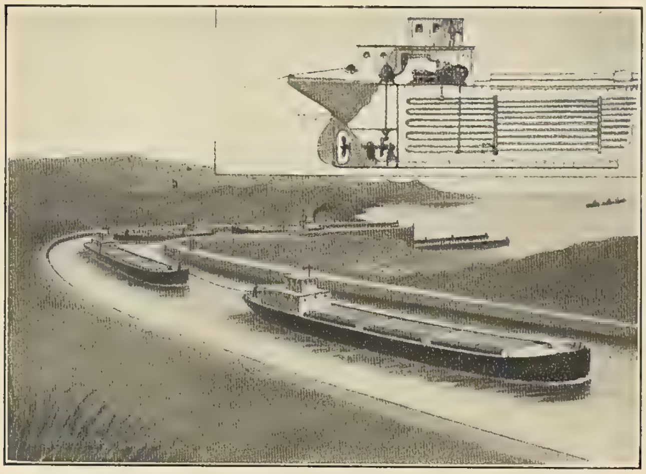


Fig. 15.—Electric Drive Applied to Canal Barges

greatly facilitate the development and sale of power afloat for the transportation of cargoes and other purposes.

Perhaps it is too early to discuss the application of this system to transatlantic passenger vessels, but it should be pointed out that with the elimination of the power plant, fuel and stores from a passenger boat, it would be entirely possible to make such a vessel absolutely safe against sinking, and that a power boat built only for that purpose could and has been made as an ice breaker of such strength and resistance that it could be driven without danger at full speed against ice.

Separate Power Boat for Sound and River Vessels

Relative to the propulsion of passenger boats in local waters, it is believed that this method offers very remarkable possibilities. Taking the steamboat lines with which we are most familiar, those running from New York to Albany and eastward on the Sound, these boats make a run of about ten hours and then lay up for the other fourteen. It is plain that a separate power boat operating one of these boats at the same rate of speed which they now make could deliver a night boat at Albany or Fall River and return with the day boat and have ample time between trips to coal up, it being understood that a power boat would go under the coal chute to receive coal, whereas a passenger boat has to have the coal brought to it and rehandled.

The elimination of the power plant upon a local passenger boat would make it entirely practical to make the boat fireproof; and for the summer season, when these boats are mostly used, it would eliminate all heat and other annoyance due to noise and cinders.

Referring to Fig. 15, there will be seen another adaptation in which a power boat is shown conducting a line of canal barges fitted up for cold storage, it being understood that the power boat would not only furnish the propelling power but also the power necessary to do the refrigerating of the cargo in transit. At the present time vast quantities of perishable goods are handled by the railroads by means of refrigerating cars, the refrigeration being carried on by icing. It is of course apparent that this transportation could be carried on with vastly greater economy by water.

Other Uses for Floating Electric Power Station

This opens up the possibility of the use of electricity generated on board vessels for other purposes than propulsion, and it is at once apparent that there is no restriction whatever as regards the use of electric power generated afloat. It can be applied to another floating vessel for any possible purpose, such as handling cargo, refrigerating, lighting, heating, electric welding, cooking, etc. It can also be transmitted ashore and used for any conceivable purpose when the power boat is not engaged in the transportation business. This function is of very great importance when northern waters, which are closed for a considerable period of the year, are considered, as the closed season is coincident with the longer nights and the very much greater demand for electricity for lighting. It is apparent that an electric power vessel could be laid up alongside of a coal supply and deliver electricity at a unit cost much less than from a power station.

A further possible use for an electric power vessel when not actually engaged in transportation is for the making of artificial ice. This, of course, would apply more particularly to warmer climates where ice is now made arti-

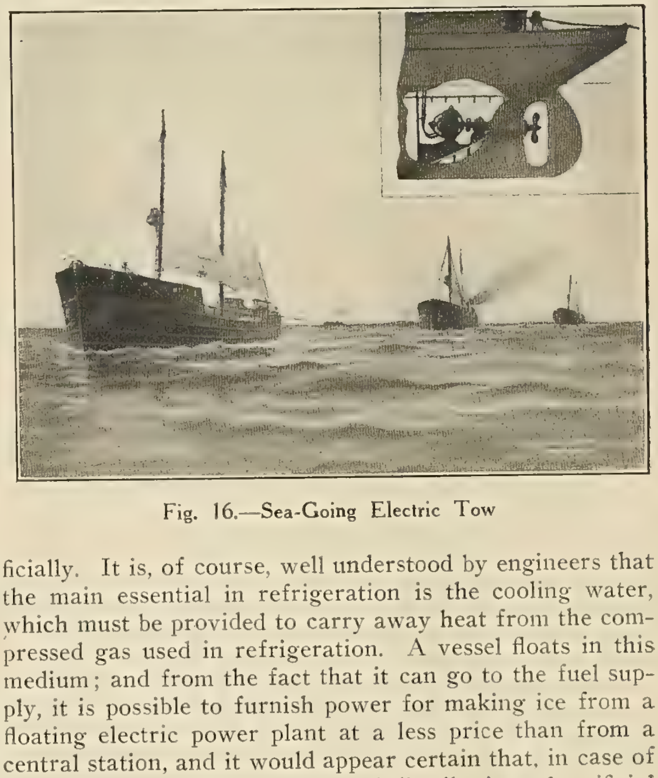
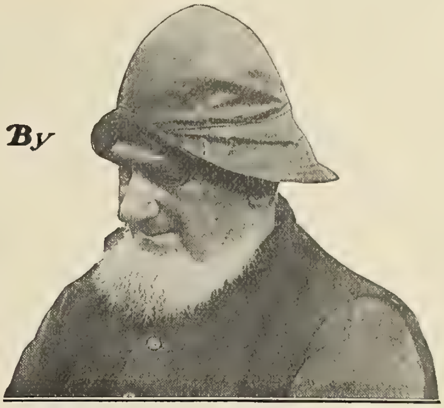


Fig. 16.—Sea-Going Electric Tow

ficially. It is, of course, well understood by engineers that the main essential in refrigeration is the cooling water, which must be provided to carry away heat from the compressed gas used in refrigeration. A vessel floats in this medium; and from the fact that it can go to the fuel supply, it is possible to furnish power for making ice from a floating electric power plant at a less price than from a central station, and it would appear certain that, in case of this development, the making and distribution of artificial ice will be very much increased.

Lecture on Submarines.—In an interesting lecture delivered in Brooklyn, N. Y., on May 13 before the New York Branch of the American Society of Marine Draftsmen, Lieut. C. W. Nimitz, U. S. N., described in detail the construction and operation of the United States submarines. It was pointed out that while the submarine is an ideal defensive weapon, especially for breaking up a blockade or for preventing landings, nevertheless it should not be considered as a substitute for battleships in the naval strength of a nation.

Economy Talks By "Old Scotch"



How to Avoid Big Repair Bills

All the methods of saving money for the owners of a ship are not confined to the operation of the machinery, by any means. No matter how careful we may be in watching the corners on coal, oil and other supplies, all that we may save in that direction can soon be wiped out in one week's repairs, if we do not watch things carefully when the ship gets into the hands of the shop people for the routine repairs.

We can prevent the necessity for a great many repairs by following the old adage of "A stitch in time saves nine," as that is very applicable to the proper care of marine machinery. If we find that some "husky" has exerted too much strength on some particular stud and twisted it off, the proper thing to do is to get busy at the first opportunity and put in a new stud. If you can locate the fellow who did the "twisting off," make him put in the new stud, as that will be a good object lesson for him to reserve his strength in the future for something strong enough to stand it. If you hear a faint sizzle in any of the boiler seams, get right after it with a calking tool and hush it up, or otherwise it will gradually develop into a serious leak, which will soon require the services of a high-priced boiler maker. If a valve starts to leak, treat it at once to a few twists of powdered glass and save a badly scoured seat later on. When a joint starts to weep, heal its sorrow at the first chance you get, either by setting up on the bolts or putting in a new gasket.

It is the attention to these small details in every-day running which prevents many of the big items of repairs at the end of the season. I know of one big steamship line which has an invariable rule that everything that is broken or missing, even to the smallest screw or nail in the ship, must be reported to the superintendent as soon as each ship gets into port. Then they go right after every little detail and fix it up. The result is that the repair bills on those vessels are kept at a minimum.

However, things will wear and accidents will happen in spite of all precautions, and occasionally our ships have to go to the shops. By using good judgment and plenty of attention the bills can be kept down, if we really want to practice economy. We don't all have to be experts to reduce costs, as just a few grains of common sense go a long ways sometimes.

For instance, I was chief of a ship not long ago which went into the dock for repairs. Of course we overhauled the sea valves, took off the strainers, etc. Much to my surprise I found a hole as big as a man's first eaten into the water side of the cast-steel sea connection to the main injection valve, up near the flange where it could not be patched. Strange to say, it had not quite gone through the casting, but there was only about a quarter-inch thickness of good metal left at the bottom of the pit.

Here was a pretty mess of fish, with dock charges of $150 (31/5/0) a day staring us in the face. An estimate was given us to furnish a new iron casting for the stool at a total cost of $450 (93/15/0), and a delay of four days in the dock. The ship was booked to sail in two days with a valuable charter, and things were popping sure enough. I indulged in a large amount of cussing; but that didn't do any good, so a happy thought came to me. I had heard a good deal of talk about this newfangled idea of oxy-acetylene welding, and it occurred to me that we might have a piece of soft iron welded into the pit.

I put the idea up to the foreman of the yard and he opined that he could make a good job of it. "Go to it!" said I, and the result was that a piece of wrought iron was welded into that hole as slick as anything you ever saw done. The total charge was $15 (3/2/6), and the ship came out of the dock on time. The owners gave me a box of Havanas for the idea, but my principal reward was in the knowledge that I had used my head for something else than a hat form.

Since that time I have saved a number of expensive repair jobs by using this useful apparatus. In my early days I would have scouted the idea that you could weld castings, and do all kinds of funny stunts such as can now readily be performed with this gas-blowing business.

In making out requisitions or specifications for repairs, you first should know exactly what you want to have done. This thing of saying, "Oh, I want this pump given a general overhauling," is what costs money. Find out exactly wherein the repairs are needed; if the water cylinder needs re-bushing, if the valve stems need renewing, or whatever is needed, make out a specific list and state clearly just what is needed, and get estimates on necessary work only. If you put down general requirements, the machine shop people will naturally want to protect themselves from any whims which the inspector for the job may develop after the contract for the job is given out, and you can bet they will provide against any losses on that account.

There are so many things to guard against, in order to save money on repairs, that I believe I will touch up this subject again later on.

Yours for economy,

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT*

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Weight of Brass Sleeve on Tail Shaft

Q.—The following question was asked on a recent examination: What is the weight of the brass sleeve on a tail shaft? Diameter shaft, 11 inches; thickness of sleeve, ¾ inch; length of sleeve, 5 feet. Will you please show how it should be worked out? S. O. H.

A.—Naval brass weighs 530 pounds per cubic foot. The volume of the sleeve is the difference in volume between two cylinders 5 feet long, one having a diameter equal to 12½ inches (to the outside of the sleeve) and the other having a diameter of 11 inches (to the inside of the sleeve).

$$\frac{\pi D^2}{4} \times L = \text{volume to outside of casing.}$$

$$\frac{\pi d^2}{4} \times L = \text{volume to inside of casing.}$$

Therefore, net volume =

$$\frac{\pi L}{4}(D^2 - d^2) = \frac{3.14 \times 5}{4}\left\{\left(\frac{12.5}{12}\right)^2 - \left(\frac{11}{12}\right)^2\right\}$$

$$= 3.93\left(\frac{35.3}{144}\right) = .964 \text{ cubic feet.}$$

$$\text{Weight} = .964 \times 530 = 511 \text{ pounds.}$$

Size of Safety Valve

Q.—What size safety valve would be required for a single-ended cylindrical Scotch boiler of 16 feet diameter by 11 feet 6 inches length; grate surface, 68.6 square feet; heating surface, 2994 square feet; working pressure, 180 pounds gage? H. M. T.

A.—The rules of the American Board of Steamboat Inspection require safety valves to have an area in accordance with the following formula:

$$a = .2074 \frac{W}{P},$$

where a = the area of safety valve in square inches per square foot of grate surface.

W = pounds of water evaporated per square foot of grate surface per hour.

P = absolute pressure, pounds per square inch.

For the boiler mentioned reasonable values of water evaporated per pound of coal and coal per square foot of grate surface per hour would be 9½ and 25, so that $W = 9\frac{1}{2} \times 25 = 238$, and the total area required for the safety valve would be

$$68.6 \times .2074 \times \frac{238}{195} = 17.38 \text{ square inches.}$$

Probably two valves would be used, each of about 8.7 square inches area. In general it may be said that safety valves should be capable of discharging all the steam that can be generated in a boiler without allowing the pressure to become excessive (say not more than 10 percent above normal), so that their size depends upon both coal burned and evaporation per pound of coal. The American rules governing this are much more logical than the European ones which follow:

(British Board of Trade for natural draft):

$$\text{area} = \frac{37.5 \times \text{grate area in square feet}}{\text{absolute pressure}}.$$

(Lloyds):

area = ½ square inch per square foot of grate area.

(French Government):

$$\text{Diameter of 1 valve} = \sqrt{\frac{\text{total heating surface (square feet)}}{\text{pressure} + 9}}$$

(English units)

(German Government):

Clear area = x millimeters per square meter of heating surface. x varies from 131 at 75 pounds to 51 at 240 pounds.

Diameter and Length of Turbine Rotors

Q.—What is the length and diameter of the rotor of a Curtis steam turbine of 1,000 horsepower capacity at 2,000 revolutions per minute, with a steam pressure of 250 pounds per square inch? Also, what is the diameter and length of the rotor of a Parsons turbine of the same horsepower and revolutions? E. M.

A.—A turbine of this power, operating at revolutions as high as 2,000 per minute, is unsuitable for marine propulsion unless the speed of the propeller is reduced by gearing. The nearest approach to it were the turbines of the *Turbinia,* which operated at about 700 revolutions per minute and developed some over 1,000 horsepower per shaft. These turbines were of the Parsons type with the high-pressure rotor 40 inches in diameter, low-pressure rotor 48 inches in diameter, the turbines having diameters over casings of 48 inches and 56 inches respectively and lengths of 8 feet 6 inches and 11 feet. A recent geared turbine installation, also of the Parsons type, had the high-pressure rotor approximately 36 inches diameter and the low-pressure rotor approximately 48 inches diameter, each rotor having a length of 10 feet. The turbines over casings were 15 feet long, and including gears about 20 feet long.

A Curtis turbine recently installed in a hgh-speed yacht had the following dimensions: 29 stages, 30-inch rotor, 300 pound boiler pressure, 1,700 brake horsepower and 1,350 revolutions per minute. Diameter over casing, 3 feet 2 inches; length over casing, 11 feet 10 inches (including thrust block and reversing turbine) and about 2 feet less excluding the reversing turbine. The weight equals 16,000 pounds.

Comparative Economy of Discharging Steam from Evaporator into Hot Well, Condenser or Low Pressure Receiver

Q.—Will you please tell me whether it is more economical to discharge the steam from an evaporator used for making up feed water into the hot well or into the low-pressure receiver of a triple expansion engine; and if it is not too much work, the method of making the calculations? S. O.

A.—It is more economical to discharge directly into the hot well, because then the heat of vaporization is retained in the ship's plant instead of being thrown overboard in the discharge from the circulating pump. The following

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calculation will be interesting as illustrative of this point.

If we assume the feed temperature to be 200 degrees F. and the evaporator is arranged to discharge normally at atmospheric pressure, the net cost in B. T. U.'s of 1 pound fresh feed water at 200 degrees when delivered, first, directly to the condenser, second, to the low-pressure receiver, and third, into the hot well and there condensed, follows:

1. It will require, in order to raise 1 pound of water into dry steam at 15 pounds absolute

NOTE: $\left.\begin{cases} x = \text{quality.} \\ r = \text{heat of vaporization.} \\ q = \text{heat of liquid.} \end{cases}\right\}$ values from Peabody's steam tables.

$$x\,r + q = 969.1 + 181.3 = 1150.4 \text{ B. T. U.}$$

less the heat of the liquid of sea water (which we may assume to be at 53 degrees F., or $q = 21.1$).

$$1150.4 - 21.1 = 1129.3 \text{ B. T. U.}$$

This is the total heat put into 1 pound of water to raise it from 53 degrees F. into dry steam at 15 pounds pressure. Assume that the temperature of the hot well is 110 degrees and 15 pounds absolute, then leading the steam directly into it, it would at once condense and give up heat equal to 1,150.4 — q (at 110 degrees) = 1,150.4 — 78 = 1,072.4. So that the actual net cost in B. T. U. has been

$$1129.3 - 1072.4 = \mathbf{56.9}.$$

2. Now if the steam is led to the condenser at 2 pounds pressure, it gives up r = 1,021.9 B. T. U. in condensing into water, and this is carried outboard and lost, and all that is conserved is

$$1150.4 - 1021.9 = 128.5;$$

therefore, the net cost of 1 pound of make-up feed water at the air pump is

$$1129.3 - 128.5 = \mathbf{1000.8}.$$

3. If we lead the steam to the low-pressure receiver, it does some work in the low-pressure cylinder which should be credited to it. If we assume 15 pounds steam per horsepower per hour, and 1.2 pounds coal per horsepower per hour, it obviously requires .08 pound of coal to generate 1 pound of steam. One pound of coal may have 14,000 B. T. U., and allowing a boiler efficiency of 60 percent, 1 pound of coal puts 8,400 B. T. U. into the water, so that .08 pound has an approximate value of 672 B. T. U., or, stated slightly differently, a pound of steam at the engine throttle has cost net about 672 B. T. U.'s. In a triple expansion engine, one might consider two-thirds of it has been utilized, leaving one-third, or 224 B. T. U.'s, available at the entrance to the low-pressure receiver. This, then, is what should be credited for each pound of steam injected into this place, so that the actual net cost in B. T. U.'s of 1 pound of feed water, if the evaporator discharges into low-pressure receiver, is the same as that when discharging into the condenser minus this credit, or

$$1{,}000 - 224 = \mathbf{776 \text{ B. T. U.}}$$

A more accurate calculation could be made if we could predict the quality of the steam in the main engine at the low-pressure receiver. If, for example, the moisture were 10 percent and the pressure 15 pounds, the total heat would be

$$Xr + q = .90 \times 969 + 181 = 1{,}053,$$

and the heat which has been put into the steam by the boilers is

$$1{,}053 - q \text{ (of feed at } 200^\circ) = 1{,}053 - 168 = \mathbf{885}.$$

To this should be added the heat put in by the feed water heater to raise the water from 110 degrees to 200 degrees (90 B. T. U.'s) and the heat of the liquid of the condensate (78) subtracted in order to get the cost in B. T. U's

$$885 + 90 - 78 = 897.$$

There has been work done in the low-pressure cylinder, however, and the heat used for this should be subtracted in order to get the net cost. If we assume adiabatic expansion from 15 pounds to 2 pounds at entropy 1.61, the heat transformed into work is

$$(x\,r + q \text{ at 15 pounds}) - (x\,r + q \text{ at 2 pounds}) = 1{,}053 - 934 = 119 \text{ B. T. U.}$$

Crediting this to the cost gives as the net cost

$$897 - 119 = \mathbf{778 \text{ B. T. U.}}$$

whch is approximately what was found by the other method of calculation.

To sum up, then, for the case in hand, it would cost to produce 1 pound of feed water by the three methods stated

(1) 57 B. T. U., if discharged into hot well.

(2) 1,000 B. T. U., if discharged into condenser.

(3) 777 B. T. U., if discharged into low-pressure receiver.

In other words it costs approximately 13½ times as much to discharge into the low-pressure receiver and 17½ times as much to discharge directly into the condenser as to discharge directly into the hot well. Where evaporators discharge directly into the condenser they operate against a less pressure than that assumed above. This, however, does not result in any material gain in economy; for while the total heat is less, the amount conserved is also less, as the heat abstracted by the condensing water remains the same.

Trials of Hydraulic Dredge

Q.—Will you kindly outline in the Department of Questions and Answers for Marine Engineers the method of procedure, and give a list of data to be ascertained in conducting a test of a new hydraulic dredge? The purpose of this test is: (1) first, to ascertain the fuel and water consumption and the general efficiency, and (2), to determine whether the equipment is properly proportioned and to discover any weak points in the design. The main equipment of the dredge is as follows: 20-inch centrifugal pump, direct-connected to 750 horsepower triple-expansion engine, with surface condenser; 12-inch by 12-inch double cylinder simple cutter engine; 10-inch by 10-inch double-cylinder throttle-reversing engine; three 12-foot by 12-foot Scotch boilers; seven auxiliary pumps; two dynamo sets; one filtering hot well and one filter for make-up water, etc. B. F. W.

A.—It is customary to require for dredges of this sort two trials, usually classified as (1) preliminary trials, (2) final trials. The preliminary trials are intended to fully test the machinery, and the pumps and pumping engines are given a continuous full-speed run of eight hours' duration with the cutter head submerged. They are operated against a head equivalent to about a mile of pipe line of the diameter of the dredge, and it is common to specify a minimum pressure at the discharge of the pump (for a case of this sort about 47 pounds). All auxiliary machinery is operated continuously for eight hours at the same time and any defects developing during these tests are made good by the contractor. Expenses of tests are borne by the contractor.

For the final trial it is customary to require that the dredge shall be given a trial of thirty working days of twenty-four hours each and all parts of the machinery which give out or show undue wear during this trial are required to be replaced at the expense of the contractor. The final trial is essentially an operating test and it is rare that the obtaining of data is attempted. In the preliminary tests, however, the plant should be made to provide a complete boiler and efficiency test and the following data should be determined:

1. Indicator cards all main engines at twenty-minute intervals. 2. Gages. 3. Weight of water fed to boilers. 4. Weight of coal fired. 5. CO_2 determination. 6. Quality of steam by calorimeter. 7. Revolutions per minute. 8. Steam consumption of auxiliaries. 9. Pressure and velocity in pipe line. 10. Calorific value of coal by sample.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

How Compressed Air Saved the Steamship Floriston

Shortly after the beginning of the war in Europe, the steamship *Floriston* sailed from Quebec under rush orders bound for England with a cargo of hulled grain. Officially, the ship has a gross tonnage of 3,429 tons and a net tonnage of 2,236 tons. However, owing to the exigencies of the hour, she was actually loaded with 4,000 tons of wheat, which put her down considerably deeper than her Plimsoll mark.

Just before clearing the Straits of Belle Isle on a dark night the ship hit an iceberg squarely bow-on when running at a speed of about 10 knots. She was so badly injured that her skipper ran her ashore upon the nearest point of the coast of Newfoundland. There for several days she pounded upon the rocky bottom and materially aggravated the damage forward. A small steamer, the *Wren*, came to the rescue of the *Floriston* and managed to pull her off and to tow her into Port Saunders—the nearest haven. The *Floriston* came to anchor in 13 fathoms of water, and at the time was drawing 31 feet forward and 22 feet 4 inches aft. After practically abandoning all hope of saving her, recourse was had to compressed air under the supervision of Mr. W. W. Wotherspoon of New York city, and the damaged craft was safely run under her own power some hundreds of miles to Quebec.

It was not until the *Floriston* reached Port Saunders that it was possible to examine her injuries. After the divers had made two surveys, it was found that the vessel's bow had been very badly crumpled up. The accompanying illustrations clearly indicate the extent. The upper and the lower forepeak were flooded, and so, too, were cargo space No. 1 and Nos. 1 and 2 ballast tanks, while ballast tank No. 3 was leaking, but could be kept under control by the ship's pumps.

The Canadian Salvage Company and the Quebec Wrecking Company took the ship in hand and started at once to make her ready for the application of compressed air—first removing about 800 tons of grain from the for-

Fig. 2.—Steamer *Floriston*

ward hold, where fermentation had started and the gasing was very noticeable. Immediately after the installation of the necessary air compressors, ballast tanks Nos. 1 and 2, and so much of the lower forepeak above the ruptured skin were placed under pressure and "blown," together with the upper forepeak, and in this way the vessel's bow was raised 4 feet, bringing her to the 26-foot waterline.

In making the air connections, the existing air vents were used in the drained compartments for conduits, while certain other air vents were sealed. In this manner complete control of the various spaces was secured from a single operating station on the main deck. In accordance

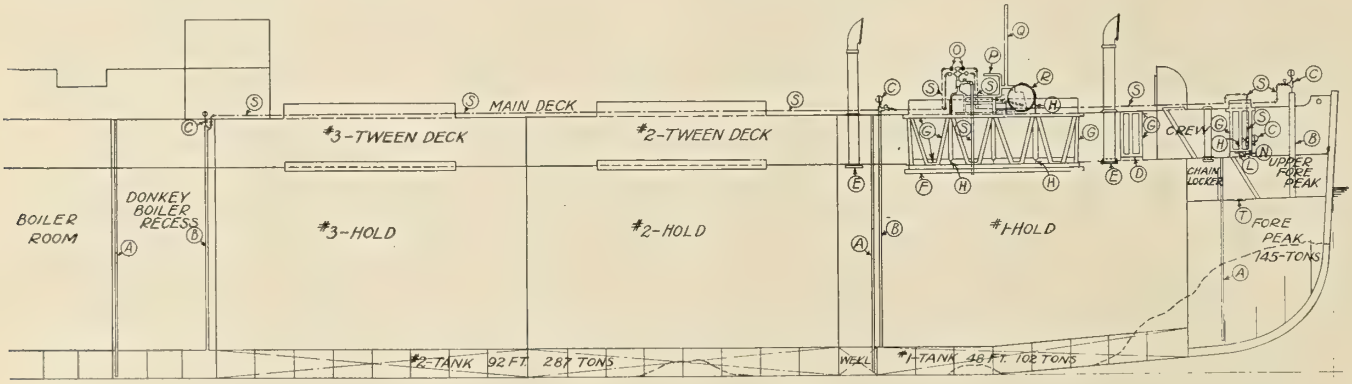


Fig. 1.—*A*, Sounding Pipes Closed to Compartments Placed Under Pressure. *B*, Air Escapes Used for Connecting Pressure Sets to Compartments Placed Under Pressure. *C*, Pressure Sets. *D*, Closing Cover for Trimming Hatch. *E*, Closing Covers for Ventilators. *F*, Closing Hatch for No. 1 Hold. *G*, Shoring and Bracing for Hatch Covers. *H*, Strong-backs Bolted to Ship's Structure. *J*, Closing Covers for Hawse Pipes. *K*, Closing Hatch for Air-lock. *L*, Underhung Escape Hatch for Air-lock. *N*, Blow-off. *O*, Control Valves for Air Supply to Compartments. *P*, Steam Supply to Compressor. *Q*, Exhaust from Compressor. *R*, Air Compressor. *S*, Air Supply Pipes to Compartments *T*, Manhole Access Forepeak

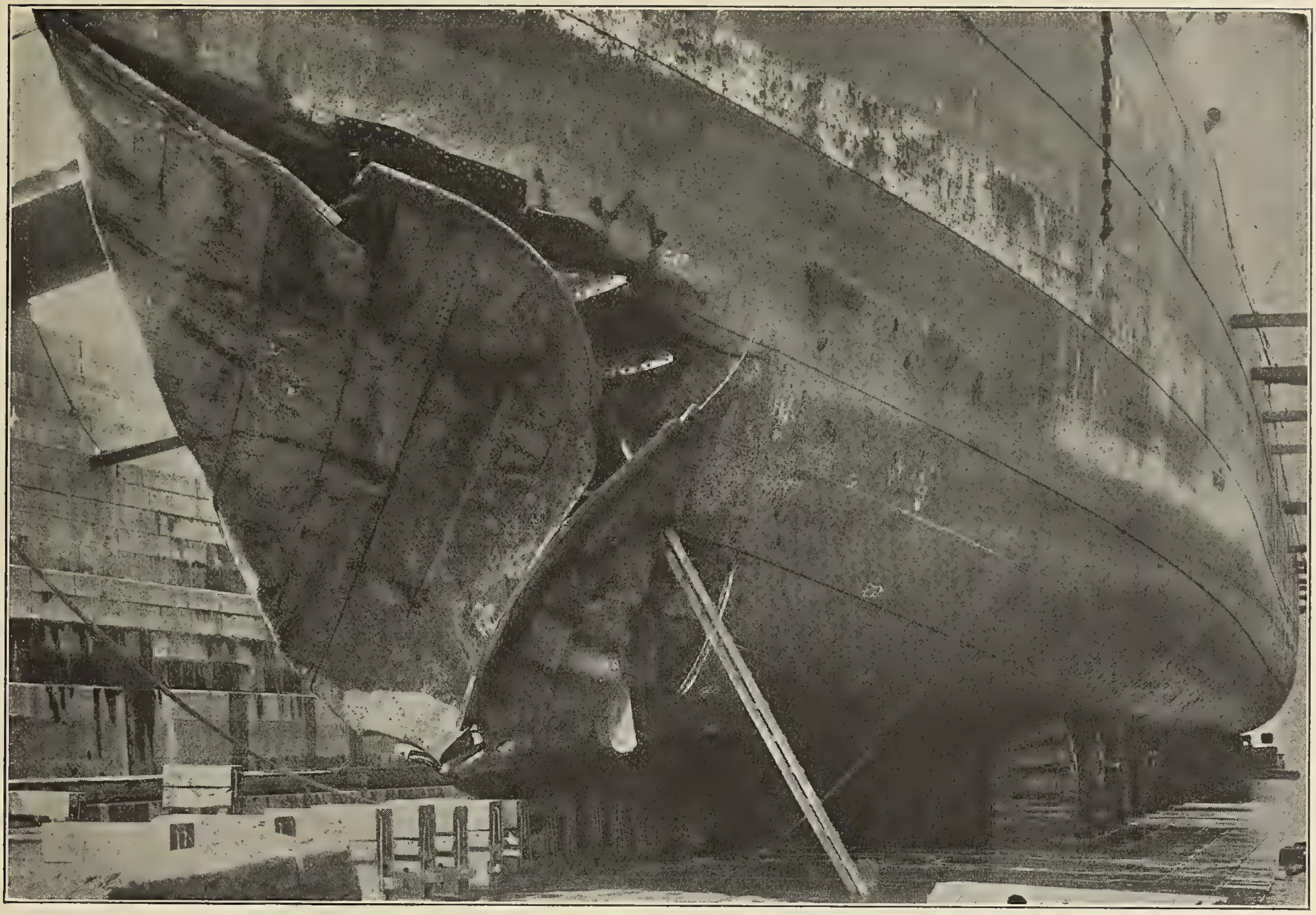


Fig. 3.—Damage to Bow of Steamer *Floriston* after Collision with Iceberg

with the Wotherspoon system the flanking compartments or neighboring spaces were also put under pressure, in order to reduce the stresses upon the divisional bulkheads and the overlying decks. The large hatch leading into cargo space No. 1 was sealed by an airtight cover composed of two layers of planking with intervening sheets of tar paper. The hatch leading into the upper forepeak was similarly sealed, with the addition of an air-lock attachment by which admission into the forepeak could be secured when that space and the compartment below were under pressure. In order to support the deck immediately above the forepeak and the cargo space, shores were placed between it and the main deck just above. This was a very necessary provision, because the *Floriston* was inclined to "hump" as she forged ahead on her long trip to Quebec, and the intermittent stresses would probably have proved fatal but for the stiffening secured by binding the two decks together in this fashion.

The entire work of preparing the *Floriston* for her run from Port Saunders to Quebec was finished in the quick time of six days, thanks to the experience previously gained in handling some other vessels in the same manner, although not so far away from bases of repair. The nature of the steamer's cargo demanded rapid action, and compressed air was the very best medium with which to battle with the gases given off by fermentation while furnishing the needful support to the confining bulkheads and deck plating. The salvers were obliged to watch this subtle foe at every stage of the homeward journey and to adjust the air pressure in the surrounding compartments accordingly.

The accompanying diagram shows the manner in which the salvage installation was made, and it is doubtful that the vessel could have been saved by any other method, considering the cargo aboard and her remoteness from any place for repairs. It was quite out of the question to use cement on the job, and compressed air was logically the only rational solution under the circumstances. The gravity of the *Floriston's* wounds are quite manifest, but because her stem and forefoot were turned so far back and upward, the first diver reported rather moderate injuries—assuming merely the rupture of the bottom plating and judging the upturned stem to be the lower edge of the break. This long trip to a repair port emphasizes the potential advantages of a permanent compressed air self-salving installation aboard large ocean-going vessels. The initial cost is moderate, and ships so equipped would unquestionably be able to obtain better insurance rates and shippers and owners feel just that much more secure.

New York. ROBERT G. SKERRETT.

Some Hazardous Experiences at Sea

While ill luck may pursue many an engineer afloat and continue very persistently, it nevertheless cannot be said that he does not benefit by such experience, especially where mishaps to machinery are concerned, as the faculty for repairing under difficulties is generally sharpened under stress and contributes towards those valuable attributes—coolness and presence of mind.

My first experience on a breakdown in the capacity of third engineeer was in a new mail steamer making a maiden trip from Sunderland to Australia for the........ line of Melbourne. Our craft was, to use a technical expression, very "tender," and having somewhat fine lines, that quality was accentuated to such an extent

that she took a list as soon as she entered the water, and only by frequent manipulation of her water ballast could she be brought upright and then only probably to take a slight heel over to the other side, so that it became talked around that she would not get to her destination.

Our troubles began on the trial trip, when the condenser tubes leaked to such an extent that the trial had to be brought to a hurried conclusion in order to make good, after which we made another final trial, and this time headed south for Dover, where the builders' engine-crowd quit. We were now four engineers, or two short of the full complement of six. Shortly after leaving Dover the condenser gave out again and we had to make for Southampton water, where on getting up gratings and taking off heavy doors, etc., it was found that several tubes had started, due primarily to the direction in which the exhaust steam entered the condenser and partly to the tubes being inefficiently packed.

After a four hours' sprint we made the job comparatively tight, and headed for the long walk. "Priming" now became the bugbear, and though much in evidence at the outset, became now more pronounced, as we had only two of the four boilers under steam. This, to some extent, caused these two to be forced to a greater extent than they otherwise would have been, and the matter of priming, incident particularly to new boilers, became considerably aggravated. Our chief's nerves evidently sustained a shock at the outset, for apart from insisting on six-hour watches, in order to "take it out of us," he frequently encouraged us by pacing the engine-room platform, waving his hands and clawing them through his hair with magnificent gesture and flourish. The fact that he was a big man and stood 6 feet 2 inches in his socks, gave the affair a certain pathos as affecting in character as it was obvious in effect.

Well, we arrived at Freemantle and congratulated ourselves for small mercies. But shortly after getting under weigh with four boilers going with the idea of making some sort of a record for the concluding part of the trip, priming set up more furiously than ever, and slob as we would with the grease brushes we could not keep the high-pressure rod from heating up even with a plentiful application of white lead, black oil and tallow. We were compelled to stop and repack the gland, after which we again proceeded, but only for a short distance, as the trouble was still there. On feeling the rod I detected grit and an inky fluid coming from the gland. It was now patent that the boiler water could not be in a state of transparency; furthermore, the feed water disclosed a very black state of affairs, inasmuch as bilge water was supplementing the feed. Though we did not know it at the time, the rod had seized on the neck ring and formed on it a sort of shallow inverted U on account of the grit which was passing through, due to the priming of the boiler water.

It appears that the chief ordered the fourth engineer to pump out the exhaust tank by means of a Weir's pump through a direct connection leading to the condenser. The valve connecting the tank and condenser was left open inadvertently. As an overflow pipe led from exhaust tank to the bilge and down into the bilge water; the result was that when the main engines were started and a vacuum created, said bilge water was drawn into the tank and condenser with the result mentioned. Consequently our high-pressure engine was fluxed with grit and dirt and was disabled. We had a four-cylinder set of triple-expansion engines with two low-pressure engines. After 17 hours' strenuous work we converted her into a compound by taking out the high-pressure piston valve and disconnecting and swinging up the rest of the engine and securely lashing the same.

When we had finished, our poor second (an extra chief) threw himself on to a heap of ashes in the boiler room through sheer exhaustion, while dancing progressed among the 200 guests or passengers (which were taken on at the Cape) and who in fact had little idea of the tension below. During the process of converting we never left the engine room and sandwiches were brought to us.

After leaving Melbourne, where the engines underwent a thorough overhaul, we made some fast trips to Queensland and way ports, and on one occasion had the satisfaction of beating the record of a competitive liner, on which we cut out a big brass sheet cock and fixed it up on the funnel as an indication to all whom it might concern that we were "Cock of the Walk." A reception and banquet which followed, with dancing which continued well into the "wee sma' hoors ayant the twal," soon enabled us to forget our past troubles.

An experience subsequent to this was in a small salvage tug. I was engaged to go out as chief to Havana and then to be transferred in a similar capacity to a Hamburg-American cargo boat which the salvage company had acquired in payment of a salvage claim. The steamer had caught fire during a conflagration on the wharves of that port and the company had sunk the craft in the harbor before the fire had done much damage.

Both the captain and myself had invested $975 (£200) in the company and my return was to be $122 (£25) per month with a percentage of profits, so it looked to be all right. My trouble began as soon as we left London, which was during severe October gales, when some 200 craft were taking shelter in the Downs. It took us a week to get around from London to Plymouth, and at Falmouth we had to negotiate for and carry out repairs incident to the severe buffeting we had sustained.

We arrived eventually at the Azores Islands, although after continual adverse winds we were left with but 1½ tons of coal. Our bilge pump broke down shortly before getting in, necessitating a few days' detention, and the water tanks had also sprung leaks. As soon as we got under weigh again we had not steamed 12 hours when a hurricane struck us and we had to turn back to repair a water cock which was letting in a big volume of water. After having made good we now set out for the longest portion of the trip to Bermuda, but persistent head winds impeded us again and again until matters began to assume a serious aspect, as our coal supply was based on the assumption of making a speed of at least five knots, whereas it seemed that at times we were not making three. We were about 350 miles from Bermuda when we were compelled to reduce speed and economize to the utmost. We accordingly sealed up one furnace, and even so, unless the winds changed, we could not possibly reach our destination on the coal that was left.

This eventually gave out, and the last ton or two was employed to maintain steam for pumping only. We were now drifting with the wind away from the track of shipping and to the southeast with a sea anchor out. We stripped the bunkers of all the floor boards and all available woodwork. Our stores were giving out, our fresh-water tank had got impregnated with sea water and for the last twenty-four hours we were in a sinking condition. To make matters worse, we had to resort to bailing out water by buckets, hand over hand, up the ladders. Our meals consisted of two sea biscuits and a few sardines. At night we burned flare lights as distress signals, and it was about 1:30 A. M. on the second night of drifting that, to our intense relief, our lights were observed by

a big steamer whose light loomed up in the distance, and on getting nearer we could discern four funnels.

She proved to be the U. S. S. fast cruiser *Birmingham*, which had made a detour much to the eastward of what was a direct course from Savannah to Hampton Roads. A welcome inquiry through the megaphone from the captain as to whether we needed assistance was answered in the affirmative, and he replied that he would send a lifeboat off at daylight. Meanwhile a powerful searchlight was directed on to us while she circled around us in wide sweeps. Oh, the exquisite pleasure of the occasion! Hardly could Paradise be more pleasurable than the state of our feelings, and if we did not cry with joy, we nearly did so. To tell the truth, our senses were somewhat numbed by the privations we had gone through.

The officers and men of the cruiser could not have treated us more kindly nor done more for us. As our craft was in a sinking condition, they fired a few shots into her before parting. This started the black cat, which formed one of our crew, and she became one of the cruiser's pets. We were taken to Norfolk, Va., and sent home by the British consul. S. E.

Victoria, B. C.

Failure of Condenser Head

Several years ago a curious accident occurred to an auxiliary condenser on one of our battleships. The sketch below shows diagrammatically the condenser with tandem circulating and air pumps. Two such condensers were carried, one in a separate compartment forward of the boiler rooms, the other in the port engine room. Ordinarily only one was kept running to handle the auxiliary exhaust and discharge from traps and drains.

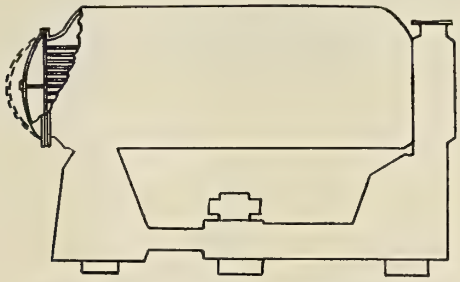


Diagram Showing Failure of Condenser Head

The forward condenser had been running all day and was shut down at 5 o'clock in the afternoon, the after one being started at the same time. The machinist's mate, who shut down the forward condenser carelessly failed to close the valve from the drain line. Of course hot water and steam from the drain line continued to empty into the condenser and must have caused it to heat up considerably.

At about half past seven o'clock that night it was desired to again start up the forward condenser. Accordingly, an oiler was sent to look after the job. He later stated on oath that he had opened the sea discharge before starting the circulating pump, and his statement was corroborated by men working in the adjoining boiler room. He did not, however, take the precaution to feel the condenser.

As soon as steam was turned on the pump it started with a bang. The cold water, coming in contact with the hot condenser tubes, formed steam and caused water hammer. Such a great pressure was created in the condenser that the pump had not made more than two strokes before the end of the bolt supporting the center of the condenser head flew off, and the condenser head itself was bulged out about six inches and cracked in the middle. The dotted lines on the figure show approximately the shape into which it was forced.

After the accident a careful examination of the damaged condenser showed no deterioration in the metal which might account for the failure. A board appointed to investigate the cause of the accident reached the conclusion that, although the sea discharge was open, the steam formed in the condenser when the pump was started caused water hammer and sufficiently high-pressure to break the bolt and distort the condenser head. H.

An Unexploded Boiler

Figs. 1 and 2 show very graphically to what extent a neglected boiler can be affected by corrosion both internally and externally. These photographs show a small Scotch marine boiler, 5 feet in diameter, 5 feet long, built with shell plates originally ½ inch thick. The boiler was built some fourteen years ago in Hongkong, China, and installed in a small harbor launch.

Fig. 1

Fig. 2

On the last annual inspection of this launch the Government inspector of boilers recommended her owner to have the boiler unshipped, so as to enable him to make a survey as complete as the size of the boiler would permit.

When landed ashore the external surface of the bottom of the shell and the lower parts of the front and rear head

plates were found covered with a layer of rust nearly 1/4 inch thick; a soft patch made of an iron sheet 1/4-inch thick, and fitted with 1/2-inch bolts, was seen also in the place indicated on both photographs. This patch was removed, the rust chipped off, and two test holes drilled in the shell, all the order of the inspector, after which the following defects, all shown in the photographs, were discovered:

Several big irregular-shaped holes (*a*, Figs. 1 and 2) on the patched part of the shell; these holes, it may be presumed without fear of contradiction, did not exist at the time the patch was fitted, or, if they existed, they were not so large, otherwise a stronger patch would have been made than the one removed. Also the existence of these holes may be attributed mostly to internal corrosion caused by the accumulation of scale on the water leg under the combustion chamber.

The thickness of the shell plate found at the test holes was as marked on Fig. 1, showing a minimum reduction of 12 percent and a maximum of 62 percent in the original thickness of the plate. Most of this reduction could be caused only by external corrosion, which is shown also on the nearly wasted away staybolt nut above the patch (*b*, Fig. 1); on the front girth seam, where the thickness of the shell plate was in some places reduced to less than 1/16 of an inch (*c*, Fig. 1); and on several rivet heads, one of the rivets having been knocked out by a few slight strokes of the inspector's hammer.

Another serious defect discovered is plainly seen in Fig. 1 at *d*. It is a crack about 18 inches long on the front head under the furnace, where the plate is flanged to join with the shell.

Notwithstanding all the above-mentioned dangerous defects this boiler, according to the engineer in charge, showed scarcely any leakage, and the writer easily believes this on account of the large quantity of incrustation found inside the boiler. This was so great that in some places, like the water leg under the combustion chamber already mentioned, and under the furnace where the crack is seen, the scale formed a solid block between plate and plate.

Why this boiler never exploded is a cause for wonder, but the moral is that all boilers which are so placed on board ships that proper care can not be taken of them, and that an inspection of the shell can be made with extreme difficulty, if at all, should be lifted from their seats once in a while, at least once in every four years, to allow a good cleaning and inspection of the boiler, as well as that part of the hull which is directly underneath the boilers. This the British Board of Trade requires in its regulations for the survey of passenger steamships. Aug. Suzara.

Performance of the Shallow-Draft Producer-Gas Barge Richmond of the Augusta-Savannah Barge Line

The tunnel stern, screw propeller river barge *Richmond*, built for the Augusta-Savannah Navigation Company, Augusta, Ga., for service on the Savannah river, has been in continual service since January 28, with the exception of a few days, which were spent in making some adjustments found necessary after the first few runs. The barge, which was described in our November, 1914, issue, is 150 feet long, 5 feet deep, 30 feet beam, with a cargo capacity of 300 gross tons. It is propelled by twin-screws driven by two 75-horsepower, 3-cylinder gas engines, built by the Wolverine Motor Works, Bridgeport, Conn., which are supplied with gas by a Galusha suction gas producer, furnished by A. L. Galusha & Company, Boston, Mass.

The usual up-stream run takes from 48 to 60 hours, depending upon the load and condition of the river. During this time the engines are continually in service, and according to reports from the owners there is every indication that the producer can supply gas practically indefinitely. The boat is required to do considerable work around the harbor in Savannah, and this service has been satisfactorily performed. The coal consumption has varied some, but the best run up-stream has shown a coal consumption of about 1.22 pounds per horsepower hour. When running the producer is charged once every three hous, so that the labor involved is very small.

Shallow-Draft Producer-Gas River Barge *Richmond*

The general performance of the boat has been such as to indicate that the tunnel stern, screw propeller type of barge is admirably suited to the kind of service which this boat has to perform. Navigation of the Savannah river is over a very crooked channel, which is subject to sudden freshets, with correspondingly high currents and with very difficult and sudden bends, which make the thorough control of the boat a matter of great importance both upstream and downstream. The stern-wheel boats, which formerly were used on this river, found it necessary when going downstream to navigate the bends in the river by stopping, backing and straightening out. With the *Richmond*, however, it has been found possible to steer straight around even the worst bends.

According to statements by the general manager of the barge line, this vessel, with its steel hull and steel cargo house, has not only given satisfactory service, but it has appealed very strongly to insurance interests, with the result that excellent insurance rates have been obtained, both on the hull and on the cargo. A second barge of the same type will soon be in operation.

Marine Articles in the Engineering Press

Performance of Motor Ships—Experiments with Counter and Reversible Propellers—New Types of Ship Construction

Nobel Marine Diesel Engine of Medium Size.—This is the description of a type of Diesel engine of three, four or six cylinders in powers of 100 to 400 brake horsepower, running at speeds from 240 to 380 revolutions per minute, according to type of mercantile or naval vessel as built by Ludwig Nobel, Petrograd. It is stated that they are installed in a half-dozen tugs on the river Volga, also in some on the Vistula and Neva—a total of 32. A full enumeration and description of the details of the engine is given regarding framng, shafting, cylinders, coupling, flywheel, valve gear, reverse, separate oil pumps, valves, injection needles and setting of reversing cams and levers. The oil consumption is given as 0.45 pound per brake horsepower for fuel and 0.006 pounds for lubrication. An account is given of an installation on a sidewheel river tug where two engines deliver their power to the wheel shaft by two pairs of 1 to 6 herringbone gears. 2 illustrations. 1,400 words.—*Schiffbau,* March 24.

Systematic Model Experiments on Tugs with Wagner Counter Propellers.—An account is given of investigations by the staff of the German Government model tank in Berlin on the efficiency of the Wagner counter propeller applied to tugboats. It was shown that quite perceptible economies up to 10 percent could be realized in this type, where large slips under heavy thrusts gave the guide vanes opportunity to deflect tangential stream lines into axial ones. Three propellers and two counter propellers were the subjects of the tests, the representative features of the wheels being determined alone and afterwards with the counter propellers. Experiments are recorded also on the influence of screws with and without counter propellers upon the bottom of canals. The corresponding erosions and sand displacements were practically only one-half where counter propellers were fitted as against cases where the wheel ran alone. An appendix is given on the theory of the propeller, giving formulas for thrust, slip, speed and horsepowers. 20 illustrations and diagrams. 8 tables. 2,600 words.—*Zeitschrift des Vereines Deutscher Ingenieure,* April 24.

The Burmeister & Wain Oil Engine.—Thirteen first class vessels, equipped with four-stroke Burmeister & Wain Diesel marine engines, are now in service, including the motor ship *Mississippi,* which is described in detail in this article. The main partculars of these vessels with the performance of the machinery are tabulated, showing the trial horsepower of the engines and the fuel consumption. The motor ship *Mississippi,* built on the Clyde, is equipped with two six-cylinder engines designed to develop 1,600 indicated horsepower each at 110 revolutions per minute. The cylinders are 27.1 inches diameter and 40.55 inches stroke. 20 illustrations. 5,250 words.—*Engineering,* February 19.

Warships of the Future.—In discussing the development of warships up to the present time, it is shown how the progress of the combative qualities of such vessels has been founded on theory in place of the trial-and-error methods which are the foundation of nearly all other mechanical engineering progress. The present war, however, has shown that, while with the type of development previously adopted, above-water attack is not dreaded, nevertheless it is the continual menace of the mine and under-water attack which controls the movements of all fleets in actual war. It is predicted that the first nation that can combine with the present type of over-water design, the merits of which have been demonstrated beyond the shadow of doubt, invulnerability below water, will have the mastery of the seas at her disposal. Such is the problem for the future. The author seems convinced that the torpedo in battleships and battle cruisers will be likely to be discarded. It is also suggested that for the destruction of submarines, the ram may be found useful, if not on regular ships of the line, at least in special ram vessels. 1,550 words.—*The Engineer,* April 9.

The Cylindrical Tank Oil-Carrying Steamer Ricardo A. Mestres.—In this vessel, constructed by Messrs. William Gray & Company, Ltd., of West Hartlepool, the oil, instead of being carried in ordinary holds with straight bulkheads, is contained in large cylindrical tanks, so that there is a freedom from webs and stiffeners on the internal surface, the consequence being that the process of cleansing is greatly expedited and more effective. The tanks are of sufficient capacity to take the full deadweight load of heavy oil and ordinary cargo or light oil can be shipped in the spaces between the outer walls of the cylindrical tanks and the sides of the ship, the space being divided up into a number of compartments by watertight bulkheads. The vessel has a length between perpendiculars of 365 feet, a beam of 50 feet 9 inches and a molded depth of 29 feet 3 inches. The total capacity of the cargo spaces is 285,793 cubic feet. There is also a bunker capacity of 26,183 cubic feet. Propulsion is by single screw triple expansion engines with cylinders 25, 51 and 68 inches diameter and 48 inches stroke, steam being supplied from three Scotch boilers at a pressure of 180 pounds per square inch. 11 illustrations. 1,300 words.—*Engineering,* April 16.

The Revival of the Reversible Blade Propeller.—The motor ship *Poseidon,* recently built by Smith's Dock Company, Ltd., of Southbank-on-Tees, for the Anglo-Saxon Petroleum Company, Ltd., the owners of the *Vulcanus, Juno,* and other interesting motor ships, is fitted with a 450 indicated horsepower Werkspoor Diesel engine, built by the Nederlandsche Fabriek and equipped with a three-blade reversible propeller. The actual swiveling of the blades in the boss is said to be a fairly simple matter, and is fully illustrated and described. The method of operating the control rod in the tail shaft, however, is not so simple, in view of the fact that connection has to be made from a stationary part to a revolving part, requiring great rigidity and strength throughout. The apparatus for accomplishing this purpose is described and the whole arrangement is compared with a similar arrangement where the Diesel engine itself is reversible. Many advantages are claimed for a power plant in which the engine itself is non-reversible, and the astern motion is obtained by reversing the blades of the propeller as compared with a plan where the Diesel engine itself must be made reversible. The superiority of one scheme over the other for small powers seems to be in doubt, while for large powers the reversible propeller has not yet been tried out. 6 illustrations. 3,000 words.—*The Engineer,* March 26.

The Performance of Motor Ships.—In reply to points raised in a previous article, discussing a report made by the chief engineer of Messrs. Burmeister & Wain, comparing the performance of steam and motor ships on simi-

lar voyages, Messrs. Burmeister & Wain have presented evidence showing first, the reason why it took a motor ship nineteen days longer to accomplish a journey of only ten miles more than that of a steamship, even though her speed was slightly greater than that of the steamship. The motor ship was delayed in harbor for loading and discharging cargo at the time harbor laborers were on a strike. The delays were due in no way to faults in the propelling machinery. The two other points raised related to repairs and overhaul of the machinery. The evidence brought forward shows that the total repairs, after extended voyages, were very slight indeed, and the cost of maintenance comparatively low. A detailed account of the exact repairs found necessary is given, and there can be no dispute as to the accuracy of the data. The total cost of repairs to the engines of the motor ship *Siam*, after her first voyage, which covered nearly 28,000 miles, was only $312.20 (£63 19s. 10d.). At the end of the second voyage, the cost of repairs amounted to $762.40 (£156 4s. 8d.). Some of the items enumerated could very properly be eliminated, as they are not directly chargeable to the engines, and, making these deductions, the cost of repairs for the first voyage would be reduced to $215.60 (£44 3s. 8d.). 2,400 words.—*The Engineer*, April 2.

The Works of Canadian Vickers, Ltd., at Montreal.—The passage by the Canadian parliament of the Dry Dock Act of 1910, providing for subsidizing ship repairing establishments in the Dominion of Canada, led to the establishment of the Canadian Vickers Works at Montreal. The construction of the establishment was begun in May, 1910, at a point where the St. Lawrence River has a width of over a mile, and the deep water channel has a minimum depth of 35 feet. The site reclaimed for the yard has a total area of 30 acres, and is triangular, projecting into the river, so that vessels leaving or entering the basin are required to be slewed only to a slight angle with the main line of the channel. The main basin has a width of 500 feet and a length of 1,000 feet. At the inner end of the basin are the building berths, and in way of the berths special precautions have been made to exclude the winter floods by means of portable cofferdams incorporated with the structure of the building shed itself. The first part of the scheme, the provision of a floating ship dry dock to meet the requirements of the Act, was completed in the autumn of 1912, the dock being constructed by the Barrow Works of Vickers, Ltd., the lifting capacity being 25,000 tons. At the same time, there was completed at the Works a ship-repairing plant comprising blacksmith, engine and boiler shops and foundry. A floating crane is also provided which has a capacity of 75 tons at 51 feet radius, with a lifting speed of 3 feet per minute; 60 tons at 66 feet radius with a lifting speed of 3 feet per minute, and 10 tons at 72 feet radius with a lifting speed of 20 feet per minute. After providing for a repairing establishment, a further development was carried out, resulting in an extensive shipbuilding establishment. The width of the shipbuilding berth is 105 feet and it is entirely closed in, so that work can proceed independently of the weather. The iron workers' shed forms a continuation of the shipbuilding berth, and, with this arrangement, it is possible to build vessels up to 1,000 feet in length. Outside of the shipbuilding shed are open berths with an available width of 250 feet. A detailed description is given of the various shops and machinery, power plant and other equipment. 14 illustrations. 5,300 words.—*Engineering*, February 5.

The Diesel Engine.—By Herr Prof. Dr. Ing. Paul Rieppel. A paper prepared for the Connecticut branch of the American Society of Marine Draftsmen and translated by Mr. A. B. Lakey. Although the ideas which first gave an impetus to the development of the Diesel engine were originally enunciated about twenty-two years ago, it required years of experiment and research before a practical engine, operating on the Diesel cycle, was put into actual use. In describing the working cycle and details of construction of the marine four-cycle Diesel engine, the author uses the type manufactured by the Maschinenfabrik Augsburg-Nürnberg as an illustration. A comparison is then made of various types, pointing out the special features of high speed engines, the two-cycle engine and the double-acting engine. A summary is given of the advantages of the Diesel engine, especially as to its economy and its adaptability to the use of various fuels. 5 illustrations. 6,000 words.—*The Journal of the American Society of Marine Draftsmen*, January and April.

The Submarine.—By C. A. Ward, Jr. The standard types of submarine boats, known as the Holland, Laubeuf, Krupp and Laurenti types, are illustrated and described in detail, showing the relative advantages of each type as regards stability, speed, sea-going qualities and cruising radius. The requirements and desirable qualities for a modern submarine of, say, 600 tons displacement, are summed up as follows: Speed, surface, say 18 knots; speed, submerged, 10.5 knots for one hour, 9 knots for three hours; radius of action on the surface, at least 2,000 miles, submerged 30 miles; reserve buoyancy, 25 to 40 percent of surface displacement; metacentric height, surface conditions, say 30 inches, submerged, 12 inches; hull to stand submersion to a depth of 200 feet, with a factor of safety of at least 2; ample safety arrangements, including drop keel, telephone buoy, submarine signal sending and receiving apparatus, lifting rings for wrecking operations, searchlight, etc. While Russia is building submarines 250 feet long with a submerged displacement of 1,000 tons and boats as large as 1,200 tons are under construction, nevertheless it is unlikely to look for surface speeds in any way comparable to those of the surface torpedo boats, because such a relatively small proportion of the submarine's weight goes into machinery for surface propulsion. In a modern heavy oil engined submarine of about 430 tons surface displacement, the proportion of weight taken by various items would be about as follows: Hull structure, 35 percent; storage batteries, motors, wiring, etc., 29 percent; oil engines and fuel, 15 percent (engines only, 7½ percent); pumps and piping, compressors, air flasks, etc., 8 percent; torpedoes and tubes, 4 percent; ballast and miscellaneous, 9 percent. This is for a boat of 14 knots speed with a radius of action of 1,500 miles at full speed or 2,300 miles at 11 knots. The engines are of 1,200 horsepower at 450 revolutions per minute. The reserve buoyancy is 45 percent of the surface displacement. Comparing this with a fairly modern torpedo boat such as the *Paul Jones*, with watertube boilers, coal fired, and reciprocating engines of 8,000 indicated horsepower, having a displacement of 470 tons and a speed of 28 knots, it is found that the machinery weighs 200 tons and the fuel 180 tons, making a total of 380 tons or 81 percent of her total displacement, 42 percent of this being in the propelling machinery. Comparing this with the 7½ percent for the propelling machinery of the submarine, it will be readily understood why it is impossible to get a corresponding amount of power, and therefore speed, in the submarine in which 35 to 40 percent of the weight goes into the structure and another 25 to 30 percent into the motive power for submerged running, leaving a margin of, say, 35 percent for oil engines and fuel and all other fittings. 4 illustrations. 5,500 words.—*The Journal of the American Society of Marine Draftsmen*, January.

New Books for the Marine Engineer's Library

Elementary Books on the Steam Engine and Marine Engineering Design—Year Book of Wireless Telegraphy

Hydraulics, Volume II: The Resistance and Propulsion of Ships. By S. Dunkerley, D.Sc. Size, 5½ by 8½ inches. Pages, 253. New York and London: Longmans, Green & Company. Price, $3.00; 10/6 net.

Supplementing a previous volume which deals with hydraulic machinery, this book takes up the question of stream lines, waves, resistance of ships, and then discusses the theoretical conditions affecting the propulsion of ships and gives data regarding actual trials of full-sized ships. The book is a rather brief but clearly presented treatment of a subject which is usually thoroughly covered in books on naval architecture and marine engineering.

Marine Steam. Second Edition. Size, 7½ by 10½ inches. Pages, 220. Numerous illustrations. New York and London, 1914: The Babcock & Wilcox Company.

While this book is issued as a catalogue descriptive of the boilers manufactured by the Babcock & Wilcox Company, the engineering data given, showing the results obtained with watertube boilers in a great many different installations, are of great interest and value from an engineering standpoint. A short historical review of the development of the Babcock & Wilcox boiler is followed by a detailed description of the present types. Throughout, the modern boiler has been compared to the ideal boiler as outlined in the late Admiral Melville's list of essential characteristics. The book is very complete. It contains much accurate data that cannot be obtained elsewhere, and should have a place in every marine engineer's library on account of the extensive use of the Babcock & Wilcox boiler in marine practice.

Elementary Manual of the Steam Engine. By Ernest V. Lallier. Size, 5 by 7⅝ inches. Pages, 266. Illustrations, 102. New York, 1913: D. Van Nostrand Company. Price, $2.00 net.

In order to help students of steam engineering who lack practical experience, and operating engineers who lack theoretical instruction, the author has compiled a manual which presents the fundamental principles of the use of steam and steam engines in an elementary manner. While the book was written for a special class of readers, the author's experience as an instructor in engineering has made it possible for him to accomplish his task in a very efficient manner. The subjects covered are reciprocating steam engines, governors, engine calculations, the indicator, heat, boilers, pumps, Corliss engines, pipes and fittings, rotary engines, internal combustion engines and lubrication. Numerical examples are used freely throughout the book, and at the end of each chapter are representative questions which will enable the reader to gage his knowledge of the text.

Simple Problems in Marine Engineering Design. Third edition. By J. W. M. Sothern and R. M. Sothern. Size, 5 by 7½ inches. Pages, 191. New York, 1914: D. Van Nostrand Company. Glasgow, 1914: James Munro & Company, Ltd. Price, $1.00 net.

The subject-matter in this book is divided into six sections: the first, giving instructions in simple mathematics; the second, general problems showing the application of elementary mathematics; and then four sections dealing with actual marine engineering problems. Section 3 contains problems on boiler design, section 4 on engine design, section 5 on speed, consumption and indicated horsepower and section 6 on marine turbine design. In each section the rules used in solving the problems are given together with examples, and then in each case a number of problems with the answers given below, leaving the students to work out the problems themselves, so that the results can be checked up with the correct answers given in the book. The book will be found very useful for self-instruction, as the problems are simple and cover a wide range of subjects relating to marine engineering design.

Graphic Methods for Presenting Facts. By Willard C. Brinton. Size, 7 by 10 inches. Pages, 371. Illustrations, 255. New York, 1914: The Engineering Magazine Company. Price, $4.00.

Anyone who may have occasional charts to prepare for reports, for magazine illustration, or for advertising, will find this work a very useful handbook, as the great variety of methods for presenting facts graphically which are given cover almost any arrangement which may be necessary. Furthermore, the right and wrong methods of presenting facts graphically are fully illustrated. The subject is treated in simple language and the contents have been carefully arranged, so that any part of the work is immediately accessible for any desired purpose.

Elementary Seamanship and Plan for Nautical Troops Boy Scouts of America. Compiled by Charles Longstreth. Size, 5 by 7 inches. Pages, 120. Numerous illustrations. New York, 1915: National Headquarters of Boy Scouts of America. Price, 25 cents.

The plan adopted for handling nautical troops of Boy Scouts of America is to use a houseboat with several small boats, suitable for both rowing and sailing. With such an equipment from 100 to 200 boys per season can receive instruction, provided the proper scout masters are available. The principal idea of this scheme is to teach the scout systematic methods that have been handed down for generations where space, water, etc., have had to be conserved in order to make life afloat possible. This pamphlet describes the organization, equipment and routine work of the Nautical Boy Scouts, gives instructions for tying knots, handling tackles, sailing small boats, handling boats in a surf, the use of the compass, the lead, and the chart and outlines the rules of the road. At the end of the book are the international rules and inland and pilot rules. While seamanship cannot be learned from books, nevertheless the information given in this pamphlet will be found extremely useful to the novice.

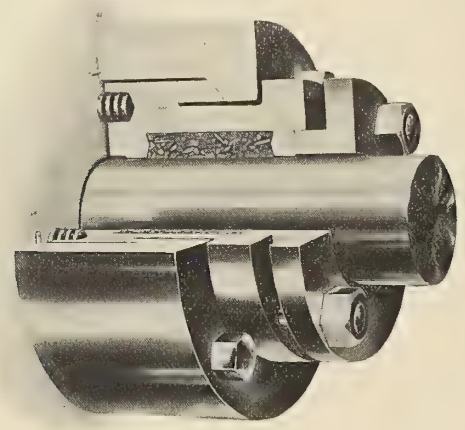
The Year Book of Wireless Telegraphy and Telephony, 1915. Size, 5½ by 8¼ inches. Pages, over 800. London, 1915: The Marconi Press, Limited. Price, 2/6 net.

A study of the 1915 issue of the "Year-Book of Wireless Telegraphy and Telephony" indicates very forcibly the immense progress that has been made in the extension and development of this form of communication during the last twelve months. The new volume serves not only as an admirable book of reference for all who have to do with the subject either in its commercial application or in the field of research, but also includes a complete historical résumé of the development of etheric wave telegraphy from its inception to the present day. All of us like to know something about the main factors which play their part in modern life, and some of us like to penetrate a little further into the mysteries, while others again already well informed are anxious to keep abreast of the latest developments. All three classes will find in the "Year Book of Wireless Telegraphy" exactly what they require.

ENGINEERING SPECIALTIES

Vibrating Stuffing Box

A vibrating stuffing box for marine engines, air compressors, steam pumps, valves, etc., which automatically adjusts itself in an out-of-line movement of the piston rod or stem, is manufactured by the Steel Mill Packing Company, Detroit, Mich., and marketed by Munro & Windas, 50 Church street, New York. As shown by the illustration, the flexibility of this stuffing box is obtained by a ball joint working in connection with the sliding face of a flange on the stuffing box. The ball joint is kept tight and free from leakage by the steam pressure and is held



Part Section of Stuffing Box

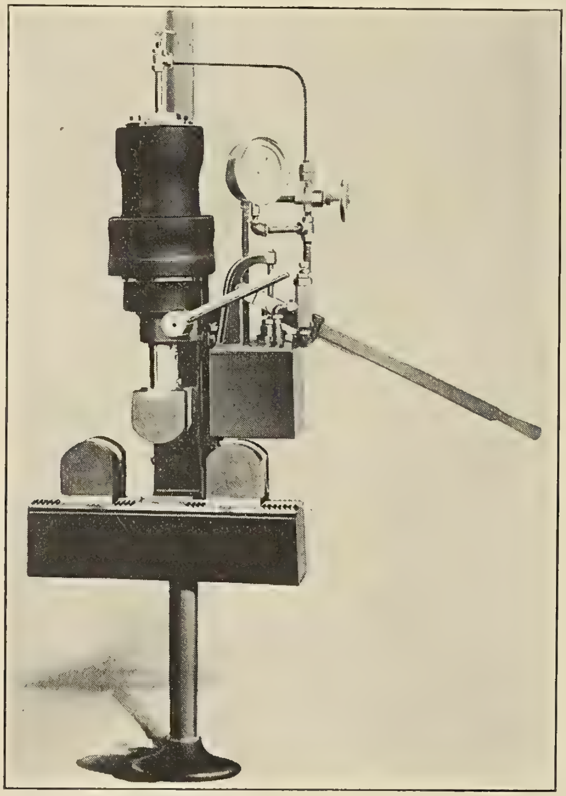
in place when the steam is turned off by the pressure exerted by small springs inserted between the cylinder head and the stuffing box. Spacing rings at each end of the packing work in connection with the packing holding the stuffing box out of contact with the piston rod, thus preventing wear. The spacing rings are made in halves, and, when necessary they can be easily replaced at small expense. Any suitable packing can be used in this stuffing box.

30-Ton Hydraulic Pipe Bender

Originally designed for bending pipe of various sizes, the press shown in the illustration is also adaptable for miscellaneous bending work which comes up in machine shops, such as bending and straightening axles, small structural shapes, bars, shafts, etc. By the use of bending blocks, pipe up to 4 inches in diameter can be bent. Clamps are provided for attaching the press to a stanchion, which has a maximum diameter of 5 inches.

The construction of the press is of steel throughout. The "C" frame and bending bed are cast in one piece. The top of the "C" frame is provided with a ring into which the cylinder sets. When the cylinder is received into this ring and turned to its desired position it is keyed into place. An advantage is claimed in having the cylinder set in a ring in this manner, because it can be placed in any position desired, bringing the handle of the rack and pinion to any point which is most convenient to the operator. Another advantageous feature is the fact that the bending blocks are changed without the use of wrenches, screws, etc.

The ram of this press is forced downward by a hand-operated pump, which has a plunger diameter of 5/8 inch and a stroke of 3½ inches. The pump is equipped with a ½-inch safety valve and ½-inch tee wheel operating valve. The reservoir is a part of the pump. A hand-operated pump is more desirable on a hydraulic press of this kind, it is claimed, because there is no danger of over-bending the pipe or other material. By the use of hand power a rapid movement of the ram may be obtained at the start when it is most desirable and when the bend has almost reached the predetermined point any desired speed of the ram can be developed. In this way just the character of bend which is wanted can be produced. The rack and pinion is provided for the rapid movement of the ram to the work before the pump is operated. The downward movement of the ram fills the cylinder with



Hydraulic Bending Press

fluid and the upward movement returns the fluid to the water box. In this manner there is no lost motion in the operation of the pump. A maximum pressure of 30 tons is developed on the press.

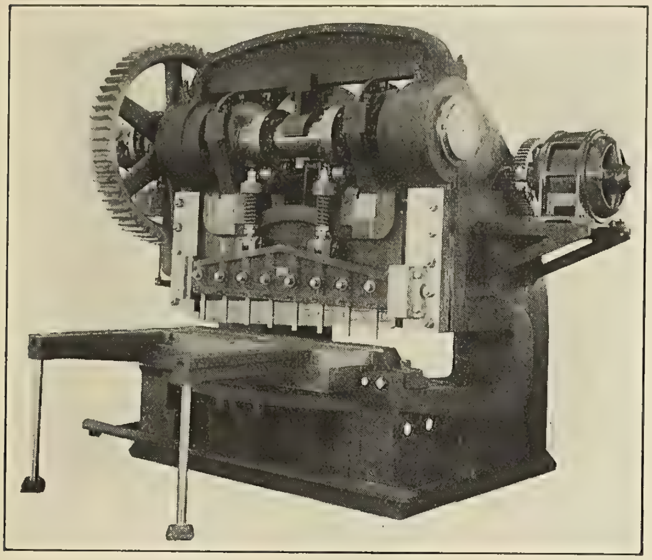
The ram has a diameter of 6 inches and a run of 9 inches. The pressing bed which receives the bending blocks is 27 inches long with a pressing width of 8 inches. When the ram is returned the distance from the top of the cylinder to the head of ram is 24½ inches. The distance between the ram head and the pressure bed is 14¼ inches. The height of the press overall is 3 feet 11 inches.

This press is a new design recently developed and added to the line of hydraulic machine tools manufactured by the Hydraulic Press Manufacturing Company, Mount Gilead, Ohio.

Heavy Gate Shear

The new heavy gate shear illustrated, which has recently been designed and built by Bertsch & Co., Cambridge City, Ind., has 72-inch blades and a capacity for cutting 1¼-inch plates the full length of the machine. It is of extra heavy construction throughout and all gears, shafts and bearings are of liberal proportions. The ma-

chine is held together rigidly by means of a bed, a cross-tie piece in the rear of the gate and a cross-tie piece overhead, all substantially bolted to the housings. An important feature of the machine is a new toggle joint clutch, for which the builder is applying for a patent. This clutch, it is claimed, is positive, noiseless and automatic.



Bertsch Gate Shear

It is actuated by means of the well-known toggle joint principle, which increases the engaging pressure against it as it engages, thereby insuring full contact of the jaws. It is disengaged by means of a hardened steel roller acting against a renewable cast steel switch ring or sleeve.

Two Handy Tools

The tools illustrated in Figs. 1 and 2 are the first of a line of small, moderately priced tools for mechanics to be put on the market by W. D. Forbes, New London, Conn. Fig. 1 shows in full size a center punch which is carefully made with both ends hardened. As the material is of the best and the workmanship accurate, this center punch will be found to be all that a center punch should be.

In Fig. 2 is illustrated a surface gage which stands 9 inches high and has a base of 2¼ inches by 2¼ inches. The needle is 9 inches long. Vertical adjustment is quickly made either by sliding the arm carrying the beam up and down on the column, or by tilting the beam which carries the needle on the arm. Micrometer adjustment of the needle is obtained by turning the knurled nut which is fitted into the jaws of the beam.

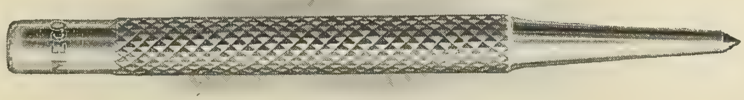


Fig. 1.—Center Punch

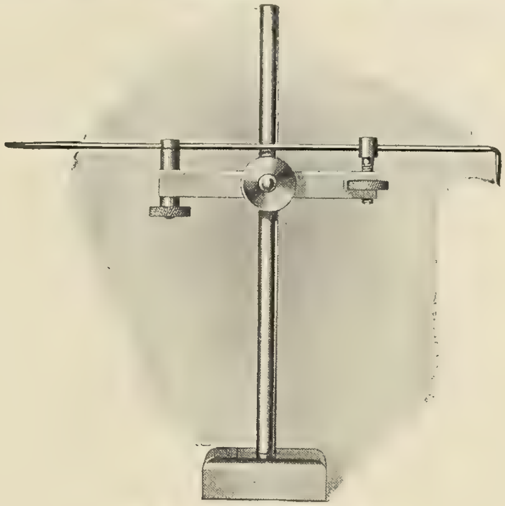
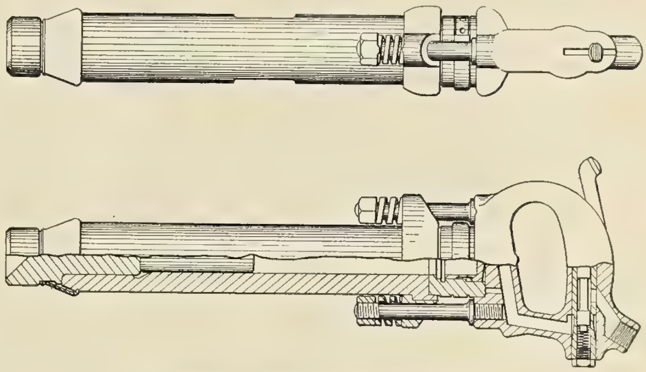


Fig. 2.—Forbes Surface Gage

New Style Riveting Hammer

George Oldham & Son Company, Frankford, Philadelphia, Pa., has placed on the market a new style riveting hammer which is built in three sizes, 6, 8 and 9 inches. This hammer is a radical departure in construction from the old type riveting hammers manufactured by this company. It embodies many novel features, conspicuous among which is the method of clamping the handle which prevents it from coming loose. As can be seen from the illustration, springs are used to absorb the shock from the blows of the hammer, so there is comparatively little reaction, thus minimizing the strains on the more vital parts of the hammer. With the old style rigid construction with threads on the cylinder engaging those on the handle, there was danger of the threads stripping, whereas in the new style tool the full shock of the hammer blows is absorbed by the springs. The throttle construction of the new style hammer is also a decided improvement, increasing, it is claimed, the efficiency of the hammer, and reducing to a minimum the possibility of leakage. Although 1½ pounds lighter than the average hammer of corresponding piston stroke, nevertheless it is claimed that this tool is just as powerful and fast and much more durable.



New Style Oldham Riveting Hammer

"Re-New-Volute" Centrifugal Dredging Pump

The illustrations show plans for a "Re-New-Volute" centrifugal dredging pump, designed by H. S. New, 90 West street, New York. The object of this design is to provide a single pump casing inclosing a lining of extreme thickness where required, variable in form within limits, simple to cast and requiring a minimum of machine work. In the design shown three sizes can be adapted to one casing, with the added feature that the volute lining may be made of metal, concrete, hard wood or other material to suit the conditions met. The pump, therefore, is adapted not only for dredging, but also for handling coal, tailings, etc., at smelters, or material containing a large percentage of corrosive acids.

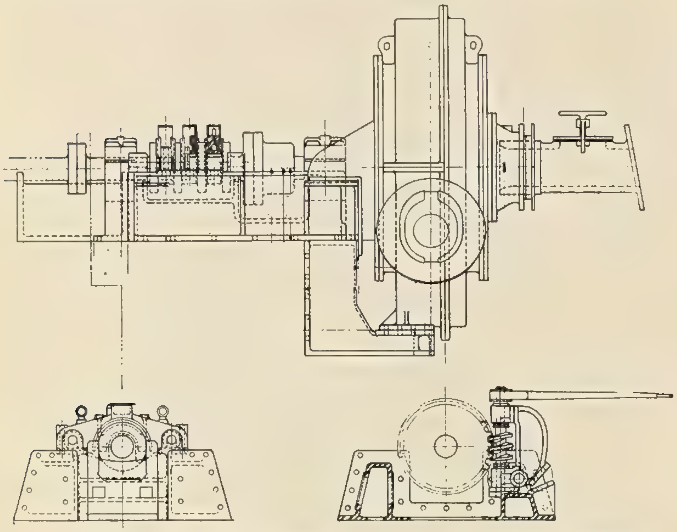


Fig. 1.—"Re-New-Volute" Centrifugal Dredging Pump

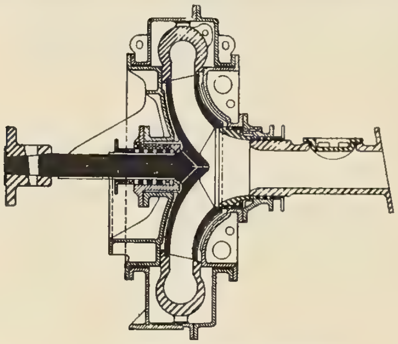


Fig. 2.—Section Through Pump

BUSINESS ANNOUNCEMENT.—The Vulcan Iron Works, Inc., of which A. J. Grymes is president and L. S. Parker vice-president, acquired on May 1 the entire plant and business of Alex. Miller & Bro., Inc., at the foot of Morris street, Jersey City, N. J., and is prepared to do all classes of boiler and machine work and repairs to steel and wooden vessels.

INTERNATIONAL CONGRESS OF NAVIGATION POSTPONED.—The thirteenth annual meeting of the International Congress of Navigation, which was to have been held at Stockholm, Sweden, during the present year, has been postponed indefinitely.

LECTURE ON ORGANIZATION.—Homer L. Ferguson, general manager of the Newport News Shipbuilding & Dry Dock Company, addressed the Newport News branch of the American Society of Marine Draftsmen recently, discussing the subject of organization as applied to shipyard management.

PERSONAL MENTION

Operating Engineers

Joseph Covert, of New Orleans, La., has been appointed first assistant engineer of the steamship *Harwood.*

A. J. McMillian, of New Orleans, La., has been appointed third assistant engineer of the steamship *Coppername.*

Thomas J. Holmes, Jr., of New Orleans, La., has been appointed second assistant engineer of the steamship *Panuco.*

Allard Jones, of Paducah, Ky., has been appointed second engineer on the river steamer *Reaper,* vice Harry Voight, resigned.

Matthew McCormack has been appointed chief engineer of the steamer *William H. Frear,* of the Troy and Albany Line, Albany, N. Y.

George Armshaw, of New Orleans, La., formerly of the steamship *Mexicana,* has been appointed chief engineer of the steamship *Panuco.*

J. S. Rankin, of New Orleans, La., formerly chief engineer of the steamship *Panuco,* has resigned to take up work in New York City.

William van Hoesen, of Albany, N. Y., formerly a river engineer, is acting as assistant engineer for the Great Lakes Dredge & Dock Company.

William Pratt, formerly chief engineer of the tug *Charles C. Wing,* has been appointed chief engineer of the tug *Eugenia,* at Waterford, N. Y.

John Butler, of New Haven, Conn., formerly with the Winchester Arms Company, has accepted a position as chief engineer of the steamer *Smith Bros.*

William Ferris, of Cleveland, Ohio, has been appointed first assistant engineer of the tug *M. A. Knapp,* which is handling tows between Troy, N. Y., and Bogart Island.

Willard Spencer has been appointed chief engineer of the steamer *G. V. S. Quackenbush,* of the Troy and Albany Line, Albany, N. Y., which opened the season on May 15.

J. W. Rowland, formerly chief engineer of the steamer *Smith Bros.,* has been appointed chief engineer of the *J. P. Randerson,* of the New Haven Towing Company, New Haven, Conn.

Thomas Hemstock, formerly chief engineer of the *J. P. Randerson,* of the New Haven Towing Company, New Haven, Conn., has been appointed chief engineer of the steamer *Dreadnaught,* of Providence, R. I.

Charles Prescott has been appointed chief engineer of the tug *George E. Lattimer,* which will be stationed at Rexford Flats on the New York State Barge Canal. Charles Hunt will be first assistant engineer of the tug.

Oliver Lang, formerly chief engineer of the steamship *Ohio* at Duluth, Minn., has been appointed chief engineer of the giant suction dredge *Massachusetts,* of the Great Lakes Dredge & Dock Company, which will be stationed at Bogart Island, above Albany, N. Y.

Charles Coggswell, of Washington, D. C., is in charge of the engine room on the steam yacht *Roxanna,* owned by Mr. Lars Anderson. The *Roxanna,* under the command

of Captain J. T. Golden, is now being made ready for a cruise along the New England coast.

William Kersey is chief engineer of the steam yacht *Gaivota*, owned by Mr. Dospason of New York. The yacht has been given a general overhaul preparatory for summer cruises on the Potomac River and Atlantic coast. Captain Keen is in command of the yacht.

C. J. Tennesson has been appointed chief engineer of the steamer *William Davis*, of the Peoples Line, Washington, D. C. This line has been established for freight and passenger service in opposition to the Chesapeake & Potomac Steamboat Company. Captain William Davis is in command of the steamer bearing his name.

George R. Smith, of Norfolk, Va., has been appointed chief engineer of the steamer *St. Johns*, of the Chesapeake & Potomac Steamboat Company, Washington, D. C. This vessel has just returned to Washington from Newport News, Va., after receiving new boilers and a general overhauling. She will be placed on the Colonial Beach route with Captain Chap Slye in command.

R. Reed and R. Harrison are chief engineers of the double crew manning the Washington city fireboat *Fire Fighter*, which has just returned to her dock after a two weeks' stay at the Washington navy yard, undergoing general repairs and painting. The *Fire Fighter* is in charge of Captains J. Stulz and J. B. Reighley. James B. O'Donnell and William Glynn are the assistant engineers.

Captain Alfred H. Harcourt, in command of the steamer *Robert Fulton*, of the Hudson River Day Line, New York, celebrated the golden anniversary of his service on the Hudson River on May 22. On that day he completed fifty years in the employ of the Hudson River Day Line, and during that time has seen the equipment of the company grow from such comparatively small vessels as the *Daniel Drew* and the *Chauncey Vibbard*, which had a capacity of about 500 passengers, to the present-day steamers *Washington Irving* and *Hendrik Hudson*, which are licensed to carry 6,000 and 5,500 passengers respectively.

Naval Architects, Consulting Engineers and Shipyard Officials

H. McL. Harding, consulting engineer and specialist in the design of marine terminals and terminal equipment, has removed his office from 17 Battery Place to 52 Vanderbilt avenue, New York.

M. C. Stewart, formerly assistant steam engineer at the Cambria Steel Company, Johnstown, Pa., has been appointed mechanical engineer at the United States Naval Engineering Experiment Station, Annapolis, Md.

Professor H. A. Everett, formerly assistant professor of naval architecture at the Massachusetts Institute of Technology, Boston, Mass., has been advanced to the grade of associate professor of naval architecture at the Institute.

At the regular meeting of the Board of Directors of the Quintard Iron works, New York, held on May 18, Mr. Stevenson Taylor tendered his resignation as vice-president of the company, which was accepted by the directors with extreme regret.

F. O. Smith has been elected president, F. O. Smith, Jr., vice-president, and J. N. Smith, secretary, of the F. O. Smith Shipbuilding & Dry Dock Company, Norfolk, Va., which has recently been incorporated as successor to the firm of Smith & McCoy. Under the new management, the firm has enlarged its docking facilities and its new dry dock is now ready to haul out vessels up to the capacity of 3,000 tons.

R. R. Row and H. C. Davis, for a number of years connected with the James Reilly Supply Company and their successors, the Griscom-Spencer Company and later the Griscom-Russell Company, have resigned to take up the sales engineering of the Standard Water Systems Company, with offices at 90 West street, New York City, and factory at Hampton, N. J. This company manufactures a full line of steam specialties for marine and stationary service, including the "Standard" multicoil feed water heater, evaporator, distiller and "Tripure" aerating still.

Lawrence Bruce, for the past fourteen years chief assistant to the superintending engineer of the Anchor Line, London, has been appointed superintending engineer of the line, succeeding Mr. Walter L. C. Paterson, who retired from active service after being connected with the line for nearly fifty years, during thirty of which he held the position of superintending engineer. Mr. Bruce, the present superintending engineer, has been with the Anchor Line for a period of twenty-seven years, having served in all grades from junior engineer to chief engineer of many of the vessels of the Anchor Line fleet, and finally as assistant superintendent, supervising the construction of new vessels and repairs to the fleet.

Obituary

Charles L. Gunn, of Paducah, Ky., chief engineer of the river steamer *Egan*, was accidentally killed while on watch on his vessel on April 27.

George H. Russell, vice-president of the Great Lakes Engineering Works, Detroit, Mich., died May 17, aged sixty-seven years.

John Lee, formerly New York manager of the White Star Line and a former vice-president of the International Mercantile Marine Company, died recently at his home in Brooklyn, N. Y., aged sixty-five years.

Albert Lloyd Hopkins, president of the Newport News Shipbuilding & Dry Dock Company, was among those lost on the *Lusitania*, which was torpedoed and sunk on May 7. Mr. Hopkins was born at Glen Falls, N. Y., September 7, 1871, and in 1892 was graduated with high honors at the Rensselaer Polytechnic Institute. In the same year he was appointed to a position in the Bureau of Construction and Repair, Navy Department, Washington, D. C. Eighteen months later he became a member of the staff of Naval Constructor J. J. Woodward, U. S. N., who was the first superintending constructor assigned to duty at the works of the Newport News Shipbuilding & Dry Dock Company. In the summer of 1897, Mr. Hopkins was assigned to the Graduate School of Naval Architecture at the United States Naval Academy, Annapolis, Md., where he was an instructor and lecturer on naval architecture and ship construction. During the Spanish war he was assigned to the naval station at Key West, Fla., where he was in charge of all the construction and repair work for the blockading fleet operating in Cuban waters. While engaged in this work Mr. Hopkins received an offer from the late W. A. Post, then general superintendent of the Newport News Shipbuilding & Dry Dock Company, to act as his personal assistant at the Newport News yard. Mr. Hopkins accepted this offer and, when in 1905 Mr. Post was made general manager of the company, Mr. Hopkins was appointed assistant general manager. In 1911 Mr. Post be-

came president of the company, on account of the death of C. B. Orcutt, and Mr. Hopkins was made manager. Upon the death of Mr. Post, in February, 1912, Mr. Hopkins was elected vice-president and became chief executive officer of the company with headquarters in New York. His election to the presidency of the company, in March, 1914, was recognized as a well-earned tribute to his ability and his devotion to the interests committed to his care. All who knew Mr. Hopkins held him in the highest esteem. Gifted with a keen mind and a strong will and personality, his education and training eminently fitted him for the position of responsibility and leadership which he filled so ably.

SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,121,563. KARL OSCAR LEON, OF NEW YORK, N. Y., ASSIGNOR TO LEON STEERING DEVICE COMPANY, OF BROOKLYN, NEW YORK, A CORPORATION OF NEW YORK. MEANS FOR AUTOMATICALLY STEERING TORPEDOES OR THE LIKE.

Claim 1.—In a torpedo, the combination of a steering device, a gyroscope connected to the said steering device so as to normally retain the course of the torpedo, receivers sensitive to vibrations of the surrounding medium, connections between the said receivers and the steering device, and means controlled by the said receivers for disconnecting the gyroscope from the steering device when a receiver is actuated. Eleven claims.

1,122,794. AUGUST T. NELSON AND CHARLES A. KLAWITER, OF MILWAUKEE, WISCONSIN, ASSIGNORS TO AUTOMATIC STEERING CO., OF MILWAUKKEE, WISCONSIN. AUTOMATIC STEERING DEVICE.

Claim 1.—An automatic steering apparatus comprising a compass-card, a contact finger carried thereby, a rotary adjustable head in axial alinement with the compass-card and above the same, a mercury-containing pot carried by the head in axial alinement with said compass-card, a downturned and extending from the contact-finger into the pot, arms carried by the head, contact members in connection with the arms for engagement with the contact-finger, means for adjusting the arms in or out with respect to the head axis, and means for spreading or contracting the arms with relation to each other. Four claims.

1,123,982. DREDGE. BENJAMIN BERNARD, OF SEATTLE, WASHINGTON.

Claim 1.—In a dredge, a ladder bracket; a bearing slidable therein; abutment members interengaged with the bracket for sliding movement; springs interspersed between the abutment members and the bearing; and adjustable elements in the bracket engaging the abutment members. Three claims.

1,124,752. GOVERNOR FOR AUTOMOBILE TORPEDOES. FRANK M. LEAVITT, OF SMITHTOWN, NEW YORK, ASSIGNOR TO E. W. BLISS COMPANY, OF BROOKLYN, N. Y., A CORPORATION OF WEST VIRGINIA.

Claim 8.—An automobile torpedo having a source of compressed fluid, an engine, and an intervening reducing valve, combined with a speed governor comprising a rotor geared to the engine, governor arms carried by said rotor and adapted to fly out under centrifugal force, a stationary member having bearings for said rotor and comprising a casing inclosing said rotor, a spring-pressed part movable in said stationary member, and connections between said part and said governor arms. Nine claims.

1,129,376. WRECK-LIFTING DEVICE. ALFRED R. BISSETT, OF VANCOUVER, BRITISH COLUMBIA, CANADA.

Claim 6.—A wreck lifting device, comprising the combination with a floatable vessel having along each side a series of flanged metal shoes each shoe curved to an ample radius and securely bedded on the deck reinforcing timbers of the vessel the shoes of one side in transverse alinement with those of the other, a windlass on each side of the middle line of the vessel between each pair of shoes, a flexible line connected to one of each pair of windlasses and passing over the shoe on the opposite side of the vessel and down to and under the submerged wreck and up and over the other shoe of each pair to the other windlass of each pair, a clamp securing each flexible line to itself where it parallels itself between the windlasses, a grooved plate between each rope and the deck timbers of the vessel and opposed wedges between the plate and the deck timbers. Seven claims.

1,129,322. HOPPER-SCREEN DEVICE. CHARLES C. WEST, OF MANITOWOC, WIS., ASSIGNOR TO MANITOWOC SHIP BUILDING AND DRY DOCK COMPANY, OF MANITOWOC, WIS., A CORPORATION OF WISCONSIN.

Claim 2.—In a sand barge of the type wherein clam shell or similar unloading devices are designed to be employed for unloading the hopper contents, the combination of the said containing hopper, means for conditioning the load therein comprising a tubular suction screening device disposed horizontally adjacent the juncture of hopper frame members, and a foraminous screening plate disposed in the path of travel of said unloading devices to extend in a protecting relation over said device and intermediately of the said frame members, said plate forming a part of said conditioning means and constructed and arranged to hold the bulk of the load away for the said device. Two claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

2,768/1914. IMPROVEMENTS IN THE LAYING OF MAGNESITE COMPOSITIONS ON SHIPS' DECKS, BULKHEADS, OR OTHER METALLIC SURFACES. H. MERRYLEES, SUTTON LODGE, CHESTER.

An improved method of laying magnesite compositions on ships' decks, bulkheads or other metallic surfaces, which consists in first covering the surface with a layer or layers of textile or the like material which is waterproofed by a thin rubber solution, and then secured to the surface, the magnesite covering being laid over the textile material.

3,262/1914. IMPROVEMENTS IN THE BEARINGS FOR THE BOTTOM TUMBLERS OR LADDER ROLLERS OF BUCKET LADDER DREDGERS. W. SIMONS & CO., LTD., LONDON WORKS, RENFREW, SCOTLAND.

The invention relates to the bearings for the bottom tumblers, or ladder rollers of bucket ladder dredgers of the type provided with means for retaining lubricant between the wearing faces and for excluding sand and water. According to the invention, a duct is provided for lubricating leading to the point of contact of a wearing plate at each end of the tumbler, revolving with the tumbler, and with a bush rotatable on the stationary tumbler shaft and a wearing plate on the bearing member carried by the ladder frame, so that the faces of these plates which take up the wear due to end thrust are efficiently lubricated.

3,995/1914. IMPROVEMENTS IN FLUID PRESSURE APPARATUS FOR OPERATING BULKHEAD AND OTHER DOORS. J. STONE & CO., LTD., DEPTFORD; F. J. PIKE AND H. NEVILLE.

Relates to fluid pressure apparatus or systems for operating bulkhead and other doors, comprising a source of fluid pressure connected with a pressure main, and door operating cylinders connected with the pressure main through respective valves, the valves being so constructed and connected up that the presence of fluid pressure in the pressure main, causes such valves to assume a position in which the pressure fluid is distributed for causing the rams to close the doors and maintain such doors in the closed position.

7,078/1914. IMPROVEMENTS IN DAVIT HEAD PINS. C. DELAHAY, 3, QUARRENDON ST., PARSON'S GREEN, LONDON.

The invention consists of a davit head pin so fitted with ball-bearings as to be non-sticking when swinging out boats at sea on board ship. The advantage of this pin is that it may be fitted to any ordinary davit by knocking out the old pin and replacing same with the new one.

7,283/1914. IMPROVEMENTS IN LOGS AND STREAM INDICATORS. W. CORNELIS, STADHOUDERSLAAM, 67, UTRECHT, HOLLAND.

This invention relates to logs and stream indicators by which jerks are imparted to a filament or wire to which a rotating member is attached. This is effected by the rotating member after a certain number of revolutions, by bringing a spring under tension and then at once releasing the spring, or by momentarily augmenting the resistance of the water. The filament wire does not rotate, but simply transfers the jerks given by the said member to the vessel, where they may be registered by a mechanism, or be felt by hand. As the jerks occur regularly after a determined number of revolutions of the rotating member the lapse of time between two successive jerks therefore indicates the rate of travel of the vessel.

8,083/1914. IMPROVEMENTS IN AND RELATING TO MACHINERY FOR THE PROPULSION OF SHIPS. W. D. McLAREN, G. M. WELSH, 124 ST. VINCENT ST., GLASGOW, SCOTLAND.

Relates to an arrangement of ship propelling machinery consisting of a reciprocating steam engine driving one propeller shaft direct, and exhausting to a high speed, low-pressure steam turbine driving another propeller shaft through the agency of a pinion and spur wheel in a known manner. The particular feature of this invention is, however, that the propeller shaft actuated by the turbine is co-axial with, and forms a sleeve on, the propeller shaft driven by the reciprocating engine and runs in a contrary direction thereto. The vessel is thus driven by adjacent propellers running in contrary directions.

14,473/1914. AN IMPROVED APPARATUS FOR SIGNALING AND RECORDING THE COURSE STEERED BY A VESSEL. R. S. O'NEIL, 39, EASTCHEAP, LONDON.

This invention relates to an improved apparatus for signaling and recording the course steered by a vessel, and has for its object to provide means whereby the position of the rudder of the vessel will be automatically signaled and the course steered by the vessel automatically recorded. The invention consists broadly in the provision of semaphore signals associated with the rudder and carrying electric lamps or other means of illumination for use at night, so arranged that when in the display position the lamps will be illuminated. The semaphore arms will be visible in daylight, and the lamps carried by them will be visible at night. The semaphore arms aforesaid are by means of suitable mechanism so associated with the rudder movements that when the position of the rudder is altered the fact will be automatically signaled. A further feature of the invention is in the provision of a recording mechanism also associated with the rudder movement which will give a graphic record of the rudder movements, and as a consequence a record of the course steered by the vessel.

2,509/1914. IMPROVEMENTS IN SUBMARINES OR SUBMERSIBLE BOATS. SWAN HUNTER & WIGAM RICHARDSON, LTD., WALLSEND SHIPYARD, WALLSEND-ON-TYNE.

Consists of a submarine having a stern provided with horizontal or diving rudder or rudders and propellers with its shafts and bearings characterized in that the propeller shaft bearings are located aft of the propeller or propellers and the propeller shaft bearing supports are used for supporting the horizontal or driving rudders.

6,891/1914. IMPROVEMENTS IN ACETYLENE GENERATORS FOR USE ON BUOYS, LIGHTSHIPS AND THE LIKE. C. W. SCOTT, LANSDOWNE BRAY, COUNTY WICKLOW, IRELAND.

According to the invention, the separate expansion chamber is cut off from communication with the external water during the time that the regular automatic action of the generator is proceeding, thereby completely eliminating any loss of illuminant due to the solution of gas in the water within these chambers, and the continual replacement of such gas-impregnated water by unimpregnated water from the outside.

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Government-Owned Ships Opposed

By a vote of more than eight to one, over six hundred trade organizations in the United States have expressed their opposition to Government ownership and operation of steamship lines in the overseas trade. This vote was in response to a referendum submitted by the United States Chamber of Commerce to affiliated organizations throughout the country to determine the sentiment of business men relative to four proposed methods of aiding the American merchant marine. While the vote was eight to one in opposition to Government ownership and operation of merchant vessels, it was thirteen to one against Government ownership and private control. On the other hand, the question of subsidies from the Government to offset the difference in cost of operation of vessels under the American and under foreign flags was approved by a vote of three to one, while subventions from the Government to establish regular mail and freight steamship lines to countries in which the commercial interests of the United States are important and to American dependencies were approved by a vote of nearly fifteen to one. If this vote indicates nothing else, it shows that the business men of the United States are becoming alive to the importance of securing legislation for the upbuilding of the American merchant marine in the foreign trade. It is seldom that a referendum vote of this kind is called for by the National Chamber of Commerce, and to find that the sentiment of its constituents is utterly opposed to any form of Government ownership in marine transportation should give the present administration cause to carefully reconsider its policy in this direction.

Experience with Diesel Motors

After nearly three years' service as chief engineer of one of the earlier large Diesel-engined tank ships, a correspondent gives in this issue an account of the difficulties and troubles which he experienced in operating this type of machinery. That considerable trouble should be experienced with early installations of marine Diesel engines was to be expected. Reliable accounts, however, of just what such troubles consisted of, and how they were overcome, are seldom made public. In the instances cited by the engineer in this issue, the defects and breakdowns were by no means as serious as might be expected, and simple remedies were sufficient to entirely overcome them. Advances are continually being made in the perfection of details of such engines, and the successful designs of marine Diesel engines are fast winning a deserved reputation for reliability. We agree with our correspondent that Diesel motors for marine work will be greatly simplified in the future. As experience is gained, mistakes will be avoided and further development will proceed along sound lines.

Naval Reserve Urged

Better coast defenses, a definite military and naval policy, a budget system for appropriating money instead of the present "pork barrel" method, an effective *mobile* regular army, better Government support for the National Guard, and the creation of an organized army and navy reserve are among the platform planks upon which the recently organized Security League is sending out an appeal for public support. It is the present plan of the League to make national defense an issue at the coming session of Congress, and with this object in view branches of the League are being organized all over the country, especially in the districts of opposition. In so far as this appeal relates to the establishment of a naval reserve, naval officers and men in the merchant marine have long been fully aware of the necessity for such an organization. Recent laws enacted by Congress provide for a naval reserve composed of men who have served in the navy, but in addition to this there is an even greater need for a thoroughly organized naval reserve composed of the men in the merchant marine. The requirements of a naval auxiliary fleet are far greater than generally appreciated, both as to the number of men and the number of ships of various classes. To meet this need a naval reserve should include every able-bodied American seaman and officer.

Modern Submarines

Submarines of the United States Navy are of two general types, the Lake and the Holland. In this issue Mr. Simon Lake, the inventor of the Lake type, contributes the first installment of a remarkable series of articles on "Modern Submarines and Submarine Appliances in War and Peace." Beginning with a statement of the present position and impor-

tance of the submarine, and the possibilities of its future development, a brief description is given of some of the early submarines, and the lessons learned from them which have been applied in modern development. In the following issues the author will take up modern submarines, explaining the principles of construction and operation, and giving a detailed description of the motive power for surface and submerged navigation and of auxiliary machinery and armament. The types of submarines in different navies will be compared and the vital question of their effect on the "control of the sea" will be discussed, as well as some speculations as to the future type of surface vessel to avoid the submarine peril, and as to the submarine's "answer."

While public attention for the last few months has been focused upon the operation of submarines in warfare, few have realized the splendid opportunities which await the development of submarine vessels in peaceful pursuits. That some of the early inventors of this type of vessel had in mind their possibilities for submarine exploration is evident from the ideas worked out in their design. The usefulness of the submarine is by no means limited to naval warfare, for, as suggested by Mr. Lake, underwater boats are feasible for transportation between icebound ports, hydrographic work, scientific investigations of sea coast bottom conditions, recovery of foodstuffs, wrecking and recovery of lost cargoes, dredging operations and the recovery of minerals, asphalts, fertilizers and the like, as well as for improving waterways, the construction of submarine tunnels, and for use in connection with the pearl, sponge and coral industries. The development of submarine boats and submarine appliances for such purposes will undoubtedly mark a new era in the progress of marine engineering.

"I Told You So!"

In our issue of November, 1913, we referred to the question of tolls in the Panama Canal as follows:

"It is not often that International Marine Engineering deviates from its text of engineering in the marine field, but the United States Government has so bungled the subject of tolls in the Panama Canal that we feel it a duty to protest. A thoroughly scientific manner of assessing tolls was presented to the Congressional Committee having the subject in charge and also to the President of the United States, but for some reason unknown to the public the old unreliable method of basing tolls on net tonnage was adopted. Net tonnage means little, if anything, depending upon the man who uses it. It is like figures which cannot lie as much as the man who uses them. Net tonnage works an injustice to some people and gives other people more than they are entitled to, especially if they wish to be tricky. Instead of simplifying the assessing of tolls it complicates it. The policy adopted by the Government opens the door to fraud upon the Government and the shipowner. Instead of being honest and perfectly fair to both sides, it deliberately drives shipbuilders and shipowners to subterfuge and petty trickery to get around the law. The action taken by the United States Government is a serious reflection upon American engineering ability and a great step backwards in these days of scientific attainments."

The authorities are already having a great deal of trouble in deciding upon what tolls to charge for deck loads of lumber and other loads that do not come under the general rules. While those officials who are responsible for assessing tolls are trying to decide upon what and how many exceptions shall be made to the general rules, shippers are complaining bitterly of excessive overcharging and threatening to appeal to the courts for protection. How simple it would have been to have adopted the block displacement system! Then there could not be any question as to how to assess tolls for deck loads of lumber or any other loads.

Pernicious Regulation

The Federal administration in Washington seems to have become obsessed with a desire to regulate everything. From our point of view it is not necessary to refer to the attempts that have been made to regulate various lines of business, or to the enormous expense these forms of regulation have caused the Government, but it does interest us to mention the attempt to regulate the merchant marine by the signing of the so-called Seamen's Bill. No outrage has been perpetrated on any struggling industry during the past half century that approaches this villainous bill. It has already caused the largest fleet of vessels flying the American flag in the overseas trade to haul down the flag, and undoubtedly other fleets will follow suit. With this horrible example before it, the adminstration now contemplates regulating motor boats, and a hearing regarding this proposed regulation was held in Washington on June 10.

The proposal was divided into three paragraphs. The first was to the effect that all small undocumented vessels navigated by machinery should be numbered and the name and address of the owner registered in the custom house. Few people realize that among the vessels of this type there are somewhere between 200,000 and 400,000 boats of 20 feet or under which are occasionally, or always, propelled by outboard motors. It is not unusual for a man to own a motor and hire a rowboat which at one time is a motor boat and perhaps an hour or so later may be a rowboat. To attempt to enforce a law of this kind will cost a very large amount of money. Furthermore, such a law cannot be enforced, as there will be thousands of motor boats run by people in regions a long distance from custom houses. Their owners would very likely not learn of the existence of such a law, or, if they did know of it, they would pay no attention to it.

The second paragraph related to the inspection of the hulls and the general condition of the engine of motor

boats carrying twenty or more passengers for hire. To attempt to enforce this would cost the United States Government hundreds of thousands of dollars, and it would require many more inspectors than the Steamboat Inspection Service now employs to inspect steam vessels. No one knows how many motor boats would come under this classification, but there must be many thousands of them, as the report of the Commissioner of Navigation for 1905 estimated that 7,500,000 passengers were carried in these boats during the year. If such a law were enacted, it would work great injustice on thousands of these motor boat owners, especially upon the men who have no money to visit the nearest custom house, unless it is within a few hours' sail, and to whom the expense of making a long trip would be really prohibitive. These men would be compelled either to give up the little business upon which their livelihood depended, or to evade the law, if they happened to know that such a law was in force.

The third paragraph refers to these same boats for carrying passengers, and requires that all operators shall be licensed by the Steamboat Inspection Service as to their knowledge of the rules of the road, ability to distinguish colors, general knowledge of motors, and the navigation of waters in which the vessels are to be used. Such a law as this cannot possibly be enforced, and, even if it could be, it would work a great injustice to thousands of these motor boat owners. Suppose a man in some remote part of Maryland, or on some river in Texas, or in almost any one of the large States on the sea coast, is running a boat which comes under this classification. To compel him to make a trip, especially when it is a long one, to the nearest inspectors for the purpose of having the hull of his boat inspected, and to take an examination as to his ability to run his boat, would probably cost him more money than he could make out of his boat in an entire season. We doubt if this law could be even partially enforced at an expense of less than $500,000 (£102,500) a year. Add to this expense the cost of registering all motor boats at custom houses, and we feel confident that the Commissioner of Navigation will find that he is running into an expense pretty close up to $1,000,000 (£205,000) a year; and this at a time when we are paying war taxes and the government is finding it difficult to pay its present running expenses.

The main reason given for desiring to have these proposals enacted into law is because the motor boat act of 1910 cannot be enforced as it is at present worded. To quote from the statement:

"During last year in the harbor of New York, 607 violators of the law were discovered. Of the offenders in these cases, not less than 25 percent gave fictitious names and addresses."

In order to make it possible for the authorities to punish this 25 percent of the violators of the law, the government proposes to penalize 500,000 to 800,000 motor boat owners. Instead of spending this large amount of money and inflicting such injustice on motor boat owners, the law of 1910 should, if necessary, be changed to give authority to those who search for violators of the law to make arrests. If a man were to give a name that was supposed to be fictitious, and could not prove that he had given the correct name, it would be a very simple matter to seize his boat and tow it to the nearest custom house, or wherever such a violator of the law should be taken. The arrest of a few such individuals would do much more toward enforcing the law than the expenditure of a million dollars in an attempt to enforce a new law which in itself would be unjust and unenforceable.

We urge the authorities to make a greater effort to enforce the present law before putting more laws on the statute books. It is wholly unnecessary to penalize hundreds of thousands of innocent motor boat owners in an attempt to catch 152 lawbreakers. The enormous expense of the proposed undertaking is unwarranted. Most important of all, the government authorities should stop regulating things that do not need regulating.

The Second Largest Merchant Marine in the World

In a statement on page 237 of our issue for June we inadvertently referred to the American merchant marine as the third largest in the world. This is an unfortunate misstatement, as the American merchant marine had nearly twice the tonnage of the German merchant marine a year ago, and, with the destruction of German tonnage during the war, which will probably approximate 1,000,000 tons, the American merchant marine will shortly have more than twice the tonnage of the German merchant marine.

In his annual report for the fiscal year ending June 30, 1914, the Commissioner of Navigation states:

"On June 30, 1914, the merchant marine of the United States, including all kinds of documented ships, comprised 26,943 vessels of 7,928,688 gross tons."

In addition to the vessels documented by the Federal government, there are countless vessels aggregating thousands of tons plying exclusively in waters within State boundaries, and these are documented only under State authority.

The unfortunate statement in our June number was taken from figures quoted in Lloyd's Register of Shipping for 1914-1915, which gives the American merchant marine credit for only 3,174 vessels of a total tonnage of 5,368,194. The Bureau Veritas is even more negligent in reporting the tonnage of the American merchant marine, and the figures seem more inconsistent, as it gives us credit for 4,096 vessels of only 3,476,637 tons.

Since the report of the Commissioner of Navigation was issued, considerably over 500,000 tons of vessels have come under the American flag under the act of Congress of last August, and a very large tonnage will shortly be added to the merchant marine owing to the large number of vessels now under construction throughout the country.

Modern Submarines in War and Peace

Present Status of the Submarine and Its Future Possibilities—Early Submarines and Lessons Applied to Modern Development

BY SIMON LAKE *

The submarine torpedo boat is just emerging from its swaddling clothes and beginning to speak for itself. Its progress and development have been retarded for many years by the lack of appreciation of its possibilities on the part of those who have had the planning of naval programs. Such men have been for the most part men of ripe years and experience, and perhaps because of these years of experience, they have become "ultra conservative" and have been inclined to "scoff" at or doubt the capabilities of any new device until it has been "tried out" by the "fire" of actual experience.

In studying the history of the development of the submarine, the author has been impressed by the showing made by Dr. David Bushnell, an American inventor and graduate of Yale in the class of 1775, who nearly sank the *Eagle* in New York harbor during the Revolutionary war by the use of his little one-man-powered submarine, the *American Turtle*. The author has also been impressed by the work of another American inventor, Robert Fulton, the man who made the steamboat a success. In England in the presence of William Pitt, then chancellor, and a large number of spectators, Fulton blew up a brig by exploding a mine which he had placed under her bottom by the use of his submarine boat. Both of these inventors were discouraged and were refused the necessary assistance to enable them to further develop their ideas regarding submarines, although they had undoubtedly shown that there were great possibilities in the underwater type of vessel.

The author believes that it is the lack of imagination on the part of the average successful business or professional man that makes him unable to recognize the possibilities of new devices until they have been tried out in practice. It needs an imagination to become an inventor or creator of new things. Notwithstanding the fact that the problem of submarine navigation has been successfully solved for the past fifteen years, it has only been within the past two years that any great naval authority has unqualifiedly endorsed submarines as being of paramount importance in naval affairs.

Admiral Sir Percy Scott, in a "strong" letter to the London *Times* a short time previous to the beginning of the present war, stated:

"The introduction of the vessels that swim under water has, in my opinion, entirely done away with the utility of the ships that swim on top of the water."

He stated further: "If we go to war with a country that is within striking distance of submarines, I am of the opinion that that country will at once lock up their dreadnoughts in some safe harbor and we shall do the same. . . .

"I do not think the importance of submarines has been fully recognized, neither do I think that it has been realized how completely their advent has revolutionized naval warfare. In my opinion, as the motor which has driven the horse from the road, so has the submarine driven the battleship from the sea."

Sir Percy Scott is, however, himself an inventor, and of course must have an "imagination" because he is the man who invented the "spot" method of gun firing which has enabled gunners to increase their efficiency several *thousand percent* in making hits.

Sir Conan Doyle, the celebrated novelist, had sufficient imagination to prophesy with such accuracy as to make his story seem almost "uncanny" as to what is actually taking place now around the coast of England in the carrying out of Germany's "submarine blockade." Mr. R. H. M. Robinson, a former United States naval constructor, who has had charge of the design of all of the United States dreadnoughts and the latest destroyers, recently stated in an article in *Harper's Weekly*, in reference to the possibility of protecting the underwater body of a ship from torpedo attack: "Several propositions have

* Member of Institution of Naval Architects (England), Schiffbautechnische Gesellschaft (Germany), Society of Naval Architects and Marine Engineers (United States) and American Society of Mechanical Engineers.

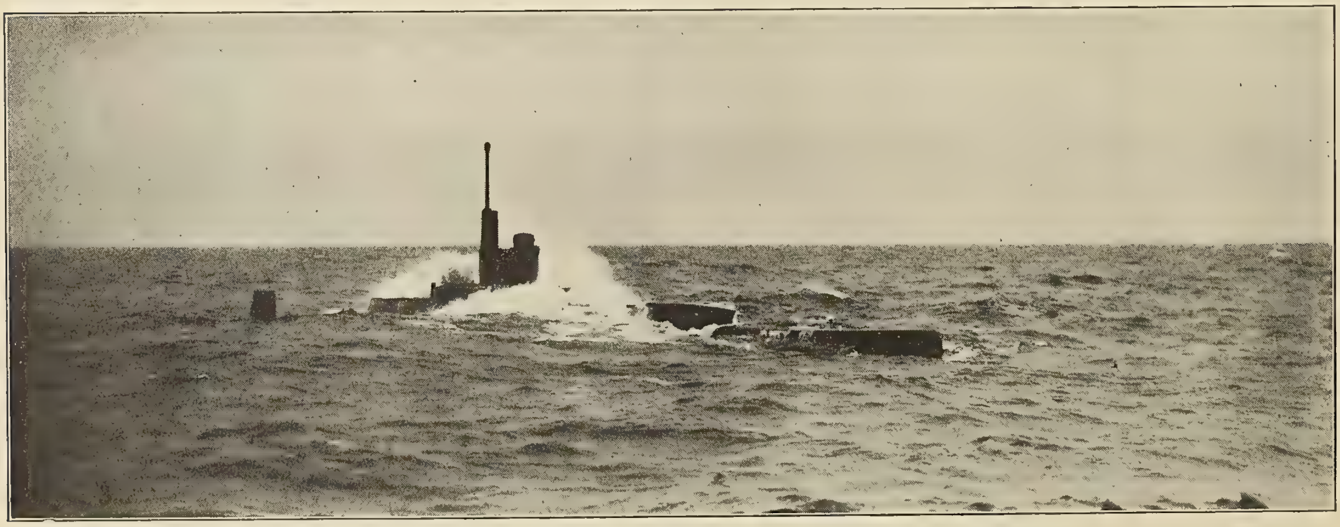


Fig. 1.—Russian Submarine *Kaiman* Making a Surface Run in the Gulf of Finland

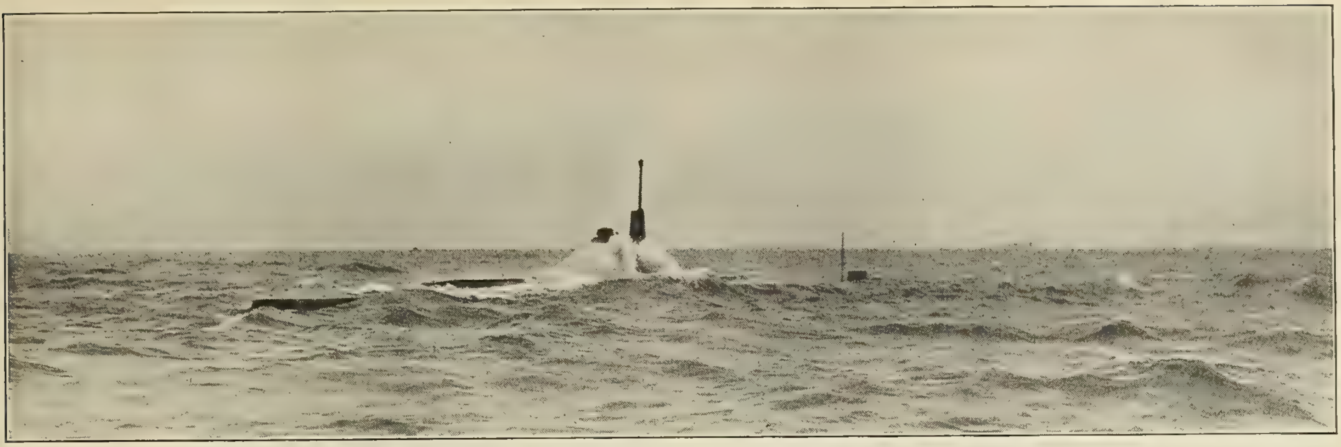


Fig. 2.—The *Kaiman* Submerging in Rough Weather

been advanced as to protecting the underwater part of the hull against torpedo damage. A favorite proposition is underwater armor. You can take it from me that such a proposition of underwater armor, at least externally applied, is absolutely futile."

Experiments have shown that a mine of sufficient power properly placed under a ship will exert sufficient force to break her in two. The force of an explosion goes in the direction of least resistance, and owing to the fact that water is practically incompressible, the line of least resistance is always upwards. Assume that it *were possible* to build a floating structure of sufficient strength to resist rupture of its plates, in that case the entire structure would probably be blown bodily out of the water.

The inventors of submarines, therefore, in the light of the opinion of high authorities and of what is happening, are justified and may perhaps be pardoned if they say, "I told you so."

International Marine Engineering has asked the writer to tell something more about the future possibilities of the submarine boat and has expressed the opinion that "now that they have made good" those interested in shipping will be able to "see" with the "seeing eye" other possibilities of the submarine, if their attention is called to them. In preparing these articles, therefore, I may make claims for submarines that have not yet been publicly proved by actual performance, and such claims may, therefore, appear to many to be as visionary as the capabilities of submarines appeared to be until within the last few months Lieutenant Weddigen of the German navy shocked the conservatives and put the submarine in its proper place by sinking, single-handed, three cruisers within one hour of each other. I shall be careful, however, not to make any claim for submarines that is not warranted from experiments actually made or from calculations based upon experiments actually made during the author's twenty-two years' continual study and experience in designing and building submarine boats and submarine appliances in the United States and abroad.

Future Possibilities of the Submarine

My study of the capabilities of submarines has led me to believe that these vessels have a greater destiny, in that they will be the means of bringing about a permanent peace between maritime nations. I do not believe that one country can invade another country by sea where submarines exist. Neither do I believe that when the submarine reaches its full development any maritime country can carry on its commerce with other countries with surface ships on the high seas as long as it is in a state of war with any one country that possesses submarines.

I believe that if the present war lasts two years longer the warring nations will have sufficient submarines in commission to demonstrate the submarines' capabilities as "peace promoters" and that there will never be another great war between maritime nations. These statements may seem "too good to be true," but the author is not alone among inventors in taking this view of the wonderful possibilities of the submarine in this respect. Robert Fulton's letter referring to his experiments in submarine warfare, said: "All my reflections have led me to believe that this application of it (the use of the mines placed by submarines) will in a few years put a stop to maritime wars, give that liberty on the seas which has been long and anxiously desired by every good man, and secure to Americans that liberty which will enable citizens to apply their mental and corporeal faculties to useful and humane pursuits, to the improvement of our country and the happiness of the whole people."

Mr. John P. Holland years ago called attention to the important fact that "submarines cannot fight submarines." This is a true statement simply because they cannot see or locate each other when submerged. It is impossible to fight with an unseen opponent under the seas.

The submarine is unique in that it is the first weapon that does not become obsolete by building a superior weapon of the same type. The contest between speed of ship and range of guns and between guns and armor has been going on ever since the gun was invented. Size and speed of ship and range of gun, and speed of projectile, have been constantly increased so that the latest ship will be able to stand off at a distance out of range of the earlier ships armed with guns built, perhaps, only a year or so before, and deliberately destroy the earlier ship without danger to herself. This early decay does not apply to the submarine for defensive purposes. Any submarine vessel that is capable of being maneuvered under water and is fitted to carry and fire Whitehead torpedoes or to plant a mine is an exceedingly dangerous craft to surface ships no matter how large or powerful such surface ships may be. The present war has shown that a Whitehead torpedo exploded beneath a battleship will cause that battleship to founder in a few minutes.

Naval architects and engineers the world over have been trying to find some means of protecting the battleship. I shall tell of these efforts in a later article, but I believe that it will never be possible to protect the heavy armored battleship from submarine attack. If surface warships are to survive they must be of an entirely new type.

The present relation of the submarine and surface vessel may be summed up as follows:

The submarine has shown its superiority over any type of surface vessel when within torpedo range.

The surface vessel has shown its superiority only in its ability to "run away" from the submarine, and in the fact that it is equipped with more reliable machinery.

The submarine has, during the present war, already forced the abandonment of the close blockade and forced the fleets of the largest and most powerful maritime nations to seek refuge behind mine-protected bases or else to keep constantly under way on the high seas, when in localities known to be frequented by sumbarines. It is one of the objects of the author to show how the present handicap of mine protection and superior speed in favor of the surface vessel may be overcome by the submarine of the future.

To understand the great possibilities of the future submarine it is necessary to study briefly the principles of the submarine's past development, so as to apply the lessons to our future designs, if these boats are to take the place they are rightly entitled to as the *mainstay of our national defense system.*

Only a few of the many experimental submarines that were built previous to the beginning of the present century taught lessons of value, because the great majority of them were total failures. However, the cause of their failures is important, because it teaches us what to avoid. Practically all the early submarines were built secretly, and if failure resulted the vessel was abandoned and the results of such trials were not published, consequently the next designer was very apt to make the same mistakes.

It was not until within the past decade that any general description of many of the early submarines was published and made available to students of the problem. The writer has been impressed in looking over the published plans and descriptions of many of the early submarines that many lives and much capital could have been saved had the results of the various experiments been published.

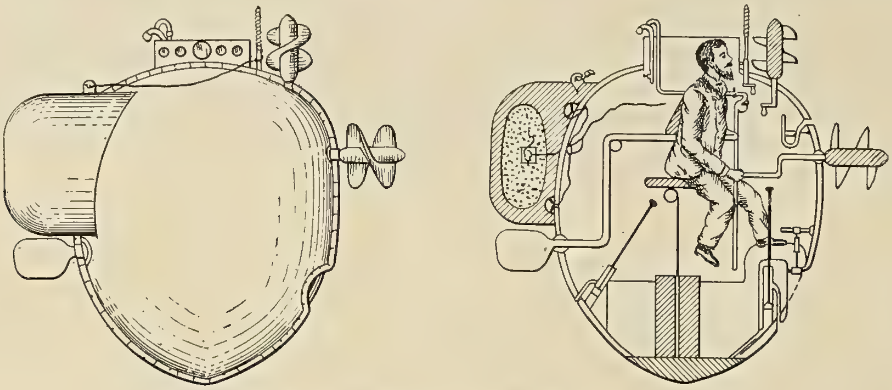


Fig. 3.—Bushnell's Submarine, *The American Turtle*

The desire to navigate in the depths of the sea has possessed the minds of many men since the beginning of history, and several crude submarines had been devised in the attempt to solve the problem. However, it was not until the period of the war between England and her American colonists that any important progress was made.

Bushnell's little submarine, called the *American Turtle,* was built at that time. It took its name from its shape, which resembled the back shells of two turtles joined together. From the rather complete description of this vessel contained in one of Dr. Bushnell's letters, it has

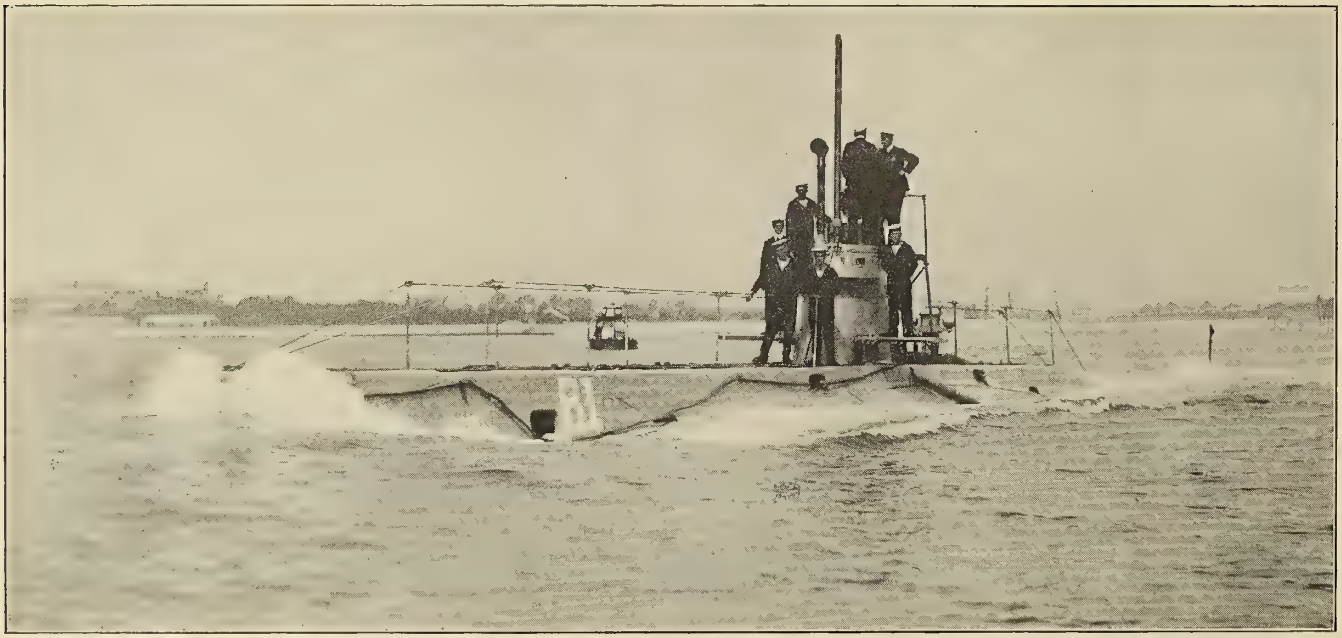


Fig. 4.—British Submarine B 1 (Holland Type), a Sister Ship to B 11, That Recently Sank the Turkish Battleship *Messudieh* in the Dardanelles. These Vessels Are Practically the Same as the C Type in the United States Navy

been found that this vessel was propelled by a screw propeller to obtain forward or reverse motion. It was ballasted in such a manner as to give the vessel great inherent stability. It had water ballast tanks which could be filled to give the vessel negative buoyancy, if desired, or to reduce the positive buoyancy so that the vessel could be readily drawn under water by another screw propeller which was operated by a vertical shaft extending through a stuffing box into the vessel. This submarine carried a mine on its back and provision was made from the interior of the vessel to attach the mine to the bottom of a ship at anchor so that the mine could be exploded by clockwork mechanism after the submarine had reached a safe distance away from the vessel.

Exploit of the American Turtle

With this vessel, a mine was placed under the bottom of the English frigate *Eagle* anchored in New York bay, but it drifted clear before the clockwork mechanism caused it to explode, otherwise the ship undoubtedly would have been destroyed. General Washington complimented Dr. Bushnell on having so nearly succeeded in his attempt to sink the ship.

This submarine was undoubtedly a successful model. It had one important feature many designers have failed to appreciate, and that was great inherent stability. Great stability in a submarine means the carrying out of the now popular maxim "Safety First." Sufficient static stability is a guarantee that during all the maneuvering evolutions of a submarine she will always remain right side up and not dive into the bottom unless the hull is punctured or flooded at one end or the other.

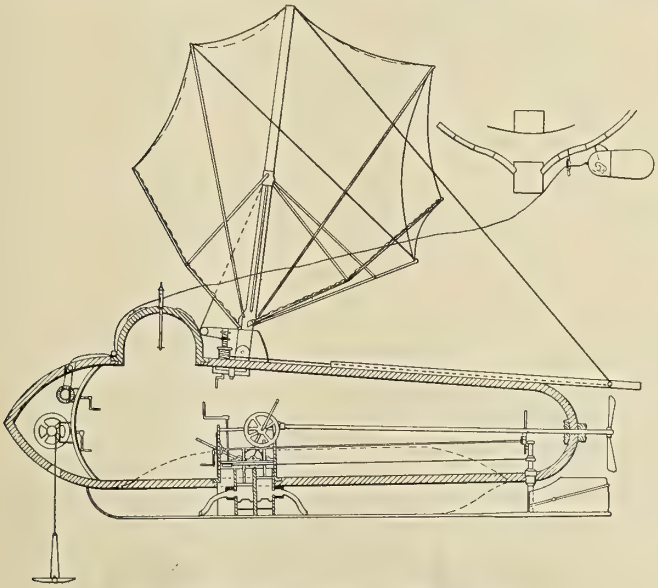


Fig. 5.—Robert Fulton's Submarine

Bushnell's model was not suited to high speed, but high speed was not essential in the days of the sailing ship. If this model had been developed further so that several men could have been used to operate the propeller, it should have given a good account of itself.

Robert Fulton's boat differed from Bushnell's in its method of submerged control, which was by vertical and horizontal rudders at the stern. It also carried a collapsible mast on which a sail could be spread for surface navigation.

A Bavarian by the name of Bauer built a submarine in 1850. Its method of control was by shifting a weight forward to dive and aft to rise. It was a flat-sided and flat-decked vessel with comparatively thin plating and entirely unsuited to resist the pressure of the water at any considerable depth. It collapsed in the harbor of Kiel during one of its trial trips. Bauer kept his presence of mind, however, and when sufficient water had entered and raised the trapped air pressure inside of the boat equal to the pressure outside he opened the hatch and swam to the surface. This vessel remained partly buried in the mud where it collapsed until 1887, when it was located during the deepening of Kiel harbor and taken to Berlin, where it is now kept in the Museum of Oceanography as an exhibit of Germany's first submarine.

Fig. 6.—Germany's First Submarine; Built by Bauer, But Lost in Kiel Roads in 1851; Located and Recovered in 1887

No further important advance was made in the art of submarine navigation until the period of the Civil War, when the Confederates built several small submarines called *Davids*. One of these was called the *Hunley* after her designer. During her brief career she suffocated or drowned thirty-two men, including her designer.

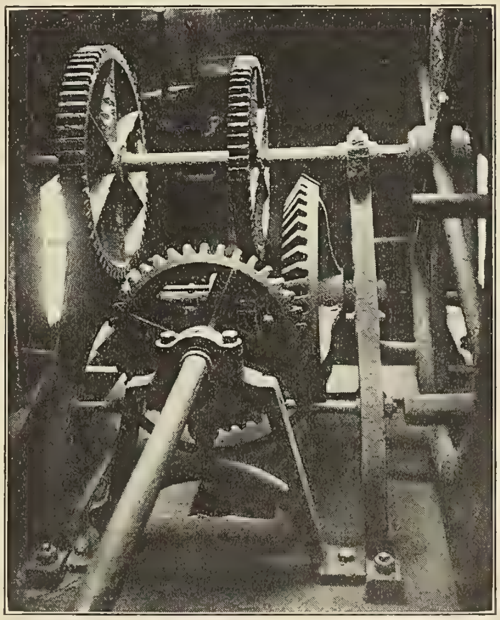


Fig. 7.—Interior View of the First German Submarine, Showing Mechanism

The author, during his early experiments with the *Argonaut* in 1898, received a visit from Colonel Charles H. Hasker, of Richmond, Va., who explained in detail the method of operating the *Hunley*. She was a cylin-

drical shaped craft about 30 feet long and 6 feet in diameter, with both bow and stern flattened to form a stem and sternpost, respectively. Water ballast compartments were located in either end of the vessel. She was propelled by eight men, who turned the cranked propeller shaft by hand. These men sat on benches on either side of the shaft. She had the usual vertically hung rudder aft, and a diving rudder forward to incline her bow down

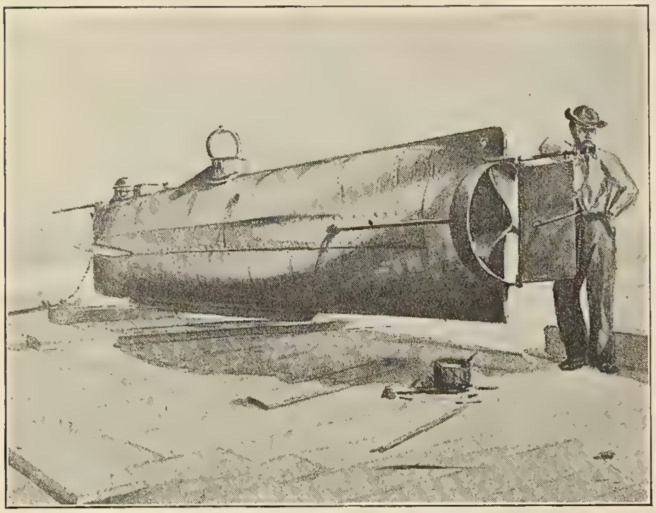


Fig. 8.—Sketch of the Confederate Submarine *Hunley*

for diving, or to raise her bow to bring her to the surface. However, she lacked longitudinal stability, and during her experimental trials twice dove head first into the bottom. She was located and recovered each time too late to save her crew, who had been thrown to the forward part of their operating compartment, where they died from suffocation, because they could not pump the vessel out when she stood on end.

Fatal Trial of the Hunley

Notwithstanding these disheartening disasters, another crew volunteered to try her again, and Colonel Hasker, who was a lieutenant in the Confederate service, volunteered as one of the crew. He stated that when the crew was made up they started out for a trial under the command of Lieutenant Payne. On this trial she was trimmed down at the dock so that she possessed very little reserve of buoyancy, and while in this condition the gunboat *Ettawan* was asked to tow them out into the stream. As soon as the submarine gained headway she started to "sheer." Lieutenant Payne attempted to throw the "bight" of the towing line off the hatch combing over which it had been placed to tow her. He became entangled in the line, and in his struggle to free himself his foot struck a prop placed under the diving rudder tiller, which threw the rudder into the diving position. She plunged head first to the bottom. Lieutenant Payne and Mr. Hasker escaped out of the forward hatch and two others escaped out of the after hatch. The other five members of the crew were drowned.

The *Hunley* was raised again and fitted with a spare torpedo. On the night of February 17, 1864, Lieutenant Dixon succeeded in approaching, in an awash condition, the U. S. S. *Housatonic,* and sank her by exploding a torpedo under her bottom. The wave thrown up by the explosion swamped the submarine (because her forward hatch was open) and again carried the submarine and her brave crew to the bottom, making a total of thirty-two men lost on this submarine, which, however, sank the first man-of-war in actual warfare. The *Housatonic* was a fine new ship of 1,400 tons displacement.

The lesson to be learned from the disastrous trials of this vessel was that sufficient statical stability should always be secured to prevent the vessel taking on an excessive inclination due to shifting of water ballast or movement of crew.

Another submarine built by the Confederates shows a much safer design. It is shown in Fig. 9 as the New Orleans submarine. According to the story told by a native of New Orleans this vessel was built during the Civil War to destroy the Northern ships. When the vessel was completed the designer thought it would be a fine performance to have the vessel plunge under water as she left the ways and make a short trip before coming to the surface. Accordingly, he instructed two of his most intelligent slaves how to operate the vessel when submerged. A large crowd assembled to witness the vessel's launching.

Launch of the New Orleans Submarine

When they were ready to launch, the two negroes entered the submarine and closed the hatch cover. She was launched with good speed and disappeared according to program, but did not reappear. Although search was made for the vessel with sweep lines and grappling hooks, she could not be found. What became of her remained a mystery for many years until, during dredging operations, many years afterwards, she was located half buried in the mud at the bottom of the harbor, and was raised. On opening the hatch the skeletons of the two slaves were found within.

It is evident the designer miscalculated and made his boat so much overweight that she could not be given sufficient buoyancy by the means provided to bring her to the surface. From a study of the form of this vessel, she

Fig. 9.—The New Orleans Submarine

should have been very stable, and I am of the opinion that she could have been successfully navigated submerged had she been properly ballasted.

During the years 1863 and 1864, Messrs. Bourgois and Brun brought out for the French navy the largest and in some respects the most completely equipped submarine that was produced during the nineteenth century. This was *Le Plongeur,* a vessel about 140 feet long, 10 feet depth and 20 feet beam, with a displacement of over 400 tons. Her motive power was compressed air engines of 80 horsepower. The compressed air was carried in air tanks at a pressure of 180 pounds per square inch. It is reported that the capacity of the air tanks exceeded 140 cubic meters.

Her submerged control system consisted of the usual

water ballast tanks for reducing the vessel's surface buoyancy preparatory to submerging. The final adjustment of displacement was to be effected by means of cylinders which could be forced out through stuffing boxes to increase her displacement or withdrawn to reduce her displacement. It was hoped that by manipulating these cylinders she could be put in equilibrium with the water she displaced and that she could then be steered in any desired direction by the vertical and horizontal rudders placed at her stern.

Theoretically this is an ideal method for submerged control, but in practice it works out badly, especially when a vessel has little stability, for the reason that there are so many disturbing influences to cause the vessel to take on dangerous angles in "diving." If "free surfaces" exist in the water ballast tanks, the slightest change from a level keel causes the water to flow to the lower end of the ballast tank. This is apt to augment still further the inclination and cause the vessel to "dive" or, vice versa, to "broach." The density of the water also varies, especially where fresh water rivers empty into salt water. At times quite different densities are found at various depths. The fresh water and salt water, instead of rapidly "mixing," seem to have a tendency to remain in "strata" which extend, in some cases, considerable distances off shore. Therefore it is practically impossible to secure and maintain a vessel in perfect equilibrium. The movement of the crew forward and aft, or the effect of the sea, which imparts a vertical motion to the water beneath the surface, all tend to destroy both trim and equilibrium to such an extent that many failures resulted in vessels of this type.

Le Plongeur was no exception to this rule, because it was found impossible to conrol her depth when running submerged, and she would either "dive" into the bottom or "broach" to the surface. One report stated that even in depths of 30 feet she would make progress "by alternately striking the bottom and then rebound to the surface like an elastic india rubber ball."

One other novel feature introduced in *Le Plongeur* was an "escape boat," which was carried on top of the main hull, to which it was secured by bolts. A double hatch connected the submarine and the "escape boat" together. In case the submarine became disabled or entangled in wreckage and could not be brought to the surface, the crew could enter through double hatches into the escape boat, secure the bottom hatch and by turning the securing bolts from the interior release the escape boat and ascend to the surface.

Mr. O. S. Halstead, of Newark, N. J., completed in

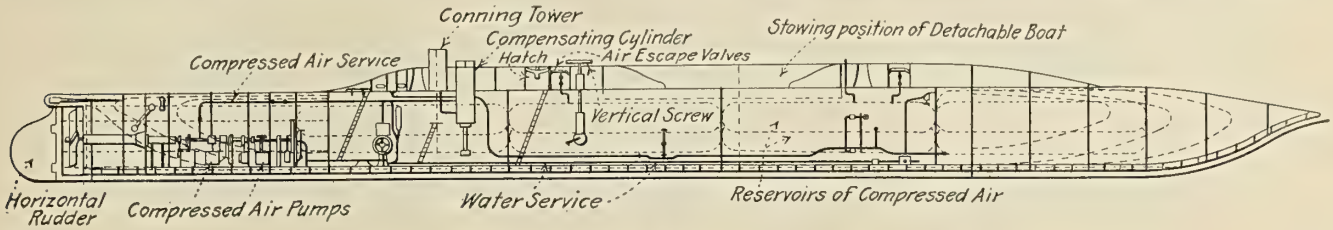


Fig. 10.—Longitudinal Section of the French Submarine *Le Plongeur*

Fig. 11.—British Submarine No. 3 Passing Nelson's Old Flagship *Victory*. This Submarine is of the Holland Type, Similar to the U. S. *Adder* and *Moccasin*

1866 a submarine vessel, on which the U. S. Government made partial payment. This vessel is known as the *Intelligent Whale*, and is now installed, as a permanent exhibit, on the Green at the Brooklyn Navy Yard, New York. The vessel had a vertical and horizontal rudder at the stern for submerged control. According to

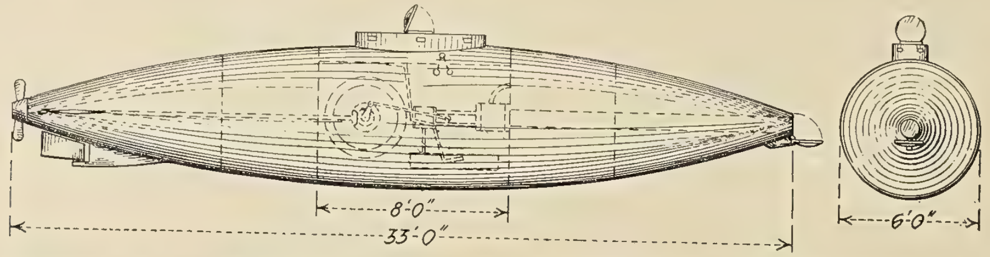


Fig. 12.—*Fenian Ram*, the First Holland Submarine Boat (1877). Sketch Made by Simon Lake After Measuring the Boat at New Haven, Conn.

official reports she must have functioned fairly well when submerged.

One of the features of this vessel consisted in its ability to be converted into a diving bell when resting on the bottom. A large trap door was arranged in the bottom of the vessel. After filling the whole interior of the vessel with compressed air equal in pressure to the pressure of the water at the bottom of the vessel, the trap door could be opened and the air pressure would keep the water from rising, the same as in a diving bell.

A study of this vessel shows that she must have been a very stable craft and not likely to "dive" at an excessive angle or to "stand on end," as was the tendency of many of the early diving boats. A report signed by General

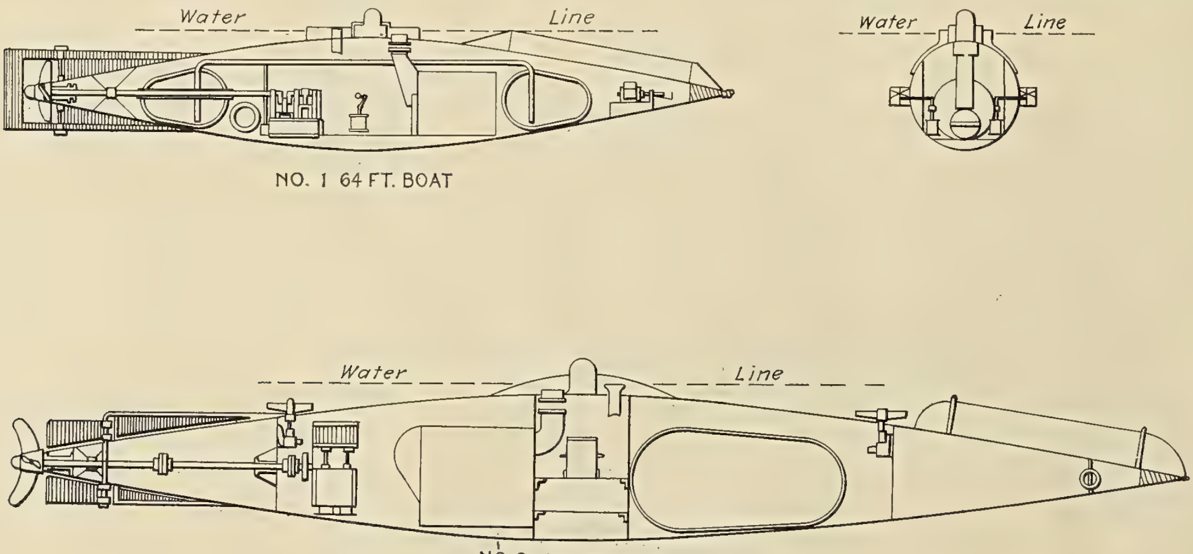


Fig. 13.—Nordenfelt Submarine Boats

T. W. Sweeny, U. S. Army, and Colonel John Michal, Colonel T. R. Tresilian and Major R. C. Bocking, engineers, strongly endorsed this vessel.

On the strength of the above-mentioned reports and endorsements, the Government through the Navy Department appointed a commission composed of Commodore C. M. Smith, Commodore Augustus L. Chase, Chief of Bureau of Ordnance, and Edward O. Mathews, Chief of the Torpedo Board, "to examine, inspect and report on the merits of said boat." As the report of this commission confirmed the capacity and efficiency of the boat for submarine purposes, the Government made a contract for her purchase for the sum of $50,000 (£10,250).

The contract specified certain conditions to be fulfilled before the final payment was to have been made, one of which was that Halstead should "write out fully and describe, without reservation, all the inventions, secrets and contrivances necessary to enable any competent person or persons to operate and manage said boat as contemplated, desired or designed, more especially the methods of furnishing, managing, controlling, purifying and renewing the air when and in quantity as needed, so as to enable those in the boat to descend and ascend or remain under water any reasonable length of time. Also to open the doors in the bottom of the boat and keep the water from coming therein at any reasonable and regulated depth." For this information Halstead was to receive such further sum as a board of officers might grant. Halstead was to have the further right to apply to Congress for additional compensation.

In carrying out the provisions of the contract, the Government on May 27, 1870, took over the *Intelligent Whale* and then paid $12,050 (£2,470) on account of the contract. Shortly after this Halstead was instantly killed. Differences then arose between Halstead's heirs and others who claimed an interest in the contract. It does not appear that anything further was ever done with the boat to carry out the terms of the contract. She lay neglected for many years on the old "Cob dock" in the Brooklyn Navy Yard, but has recently been erected as an exhibit on the "Green."

Mr. J. P. Holland brought out, in 1876, a submarine vessel called the *Fenian Ram*. This vessel was about 30 feet long and 6 feet in diameter. She was navigated when submerged by the use of vertical and horizontal rudders located at the stern. The novel feature introduced

in the vessel was an underwater air gun which was designed to fire a shell under water.

Mr. Holland was a school teacher in Ireland, from which country he was exiled because of his political beliefs. On coming to the United States he became affiliated with the Fenian movement. The money to build the line, into which the submarines were to have been floated and a sea door closed. On arrival on the English coast, this special ship, which was apparently a harmless merchantman, was to locate the British war vessels in some of the harbors, sail in and anchor near them, then the little submarines would be released from their "mother ship"

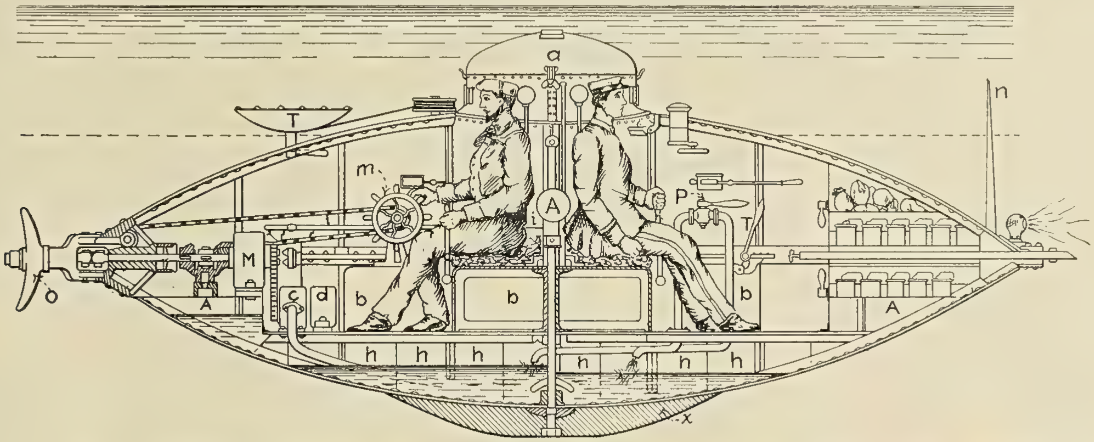


Fig. 14.—Longitudinal Section of *Goubet I*. *A*—Trimming Tank System. *a*—Conning Tower. *b*—Compressed Air Reservoirs. *c d*—Pumps. *h h*—Water Ballast Tanks. *i*—Electric Accumulators. *m*—Wheel for Moving Propeller to Port or Starboard. *M*—Electric Motor. *P*—Water Ballast Control. *T*—Torpedo. *O*—Propeller. *X*—Safety Weight. *n*—Submerging Batten.

Fenian Ram was subscribed by the "Clan na Gael" and other Irish patriotic societies. An associate of Mr. Holland recently informed the writer that over $200,000 (£41,000) was subscribed to enable Mr. Holland to carry on his experiments.

Previous to his construction of the *Fenian Ram*, Mr. Holland built a small one-man boat. After the collapse and proceed to sink as many of the British ships as they could by firing explosive shells into them below the waterline. The novelty of such an attack was relied upon to spread consternation among the British fleet and enable the submarines to escape.

In 1878 Mr. G. W. Garrett, of Liverpool, took out a patent and brought out a small boat whose equilibrium

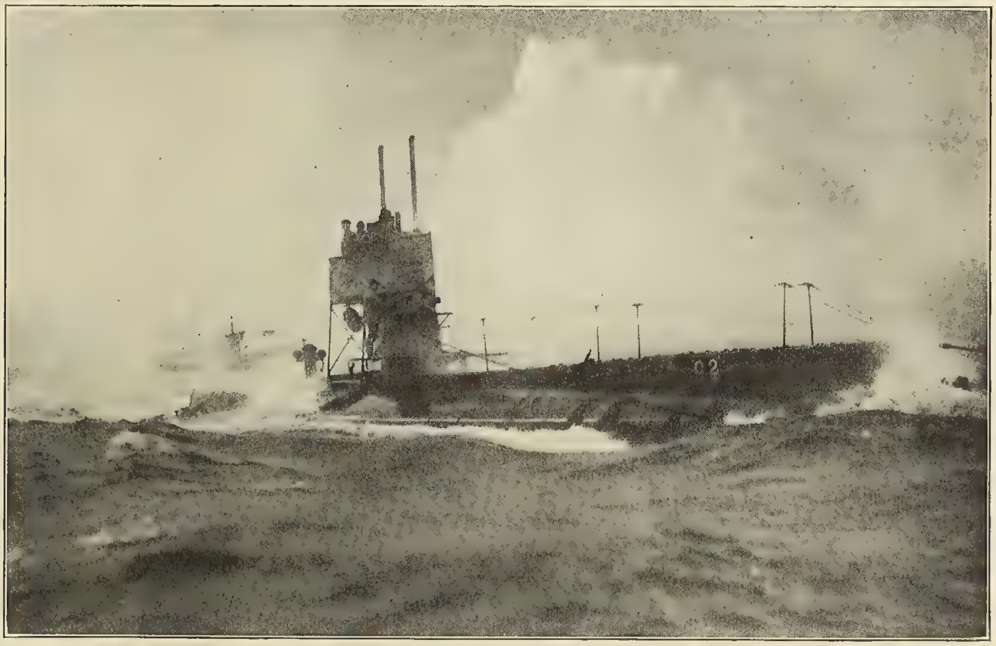


Fig. 15.—British Submarine C 2 Arriving at Portsmouth in a Gale. Note Hydroplanes at Center of Conning Tower: in Later Types These Were Placed Under the Water

of the Fenian movement the *Fenian Ram* was towed up to New Haven, Conn., and hauled out on the banks of the Mill River, where it has lain ever since, hidden under a pile of lumber.

One of the former leaders of the Fenians recently informed the author that the scheme was to build a number of submarines of about the size of the *Ram*. They were to have been carried across the Atlantic in a special ship with watertight compartments extending below the water- was to have been maintained by the admission of water into a cylinder and forcing it out by a piston. In 1879 Mr. Garrett brought out a larger vessel called the *Resurgam* in which his means of control were forward diving rudders similar to those of the Confederate *Hunley*. The novel feature of this vessel was the installation of a very large steam boiler in which sufficient heat could be stored to continue to give off steam to enable the vessel to make a submerged run of several miles after the fires were shut

down. This vessel was lost during her experimental trials.

Mr. Garrett then interested Mr. Nordenfelt, the inventor of the celebrated Nordenfelt gun, in his boat. Mr. Nordenfelt improved upon Garrett's boat and built vessels for Greece, Turkey and Russia. His first boat was 64 feet in length by 9 feet beam, with a displacement of about 60 tons. His means of submerged control was by the use of two downhaul screws located in sponsons on either side of the vessel. These screws were operated by bevel gears and were run at sufficient speed to overcome the reserve of buoyancy. The vessel was intended to be always operated with a reserve of buoyancy. Therefore, to submerge it was necessary to run the propellers at a speed sufficient to exert a thrust to overcome this buoyancy and pull her bodily under water. After reaching the desired depth, forward motion was then to be given by the usual screw propeller and she was expected to make progress on a level keel and in a horizontal plane. The level keel was to have been maintained by the use of a horizontal rudder placed in the bow.

This method of submerged control seems to me to be an excellent one in principle for moderate speed submarine vessels. I have been surprised that further development was not made along these lines. I think the final abandonment of the Nordenfelt type of vessel was due to failure in carrying out the details of design rather than to faulty principle. A former chief engineer of Mr. Nordenfelt informed me that the heat from the large amount of hot water stored up in the reservoirs (for submerged power) made it almost unbearable for the crew when the hatches were shut down, and that he did not believe the submarines ever made any submerged runs after being delivered. I also judge from his description of his experiences in the vessels that they lacked longitudinal stability and were difficult to be kept in the horizontal position which Mr. Nordenfelt claimed was a "sine qua non" for a submarine boat. I concur in this claim.

In an article on his boats Mr. Nordenfelt stated they were very sensitive, and that he purposely made them so in order that the horizontal rudder would easily maintain the boat in a horizontal position. My experience has led me to prefer great statical stability rather than sensitiveness.

Mr. Nordenfelt's boats had means for discharging, under water, the smoke from the fires so as not to betray the sumbarine's position to surface vessels. He also seems to have been the first to incorporate within his hull torpedo tubes for the discharge of the Whitehead torpedo.

Lieutenant Isaac Peral built in 1887 a vessel in which the motive power was supplied from electric accumulators. It was operated by the usual vertical and horizontal rudders. Its submerged control was bad, but its electric propulsive system worked well.

Mr. Goubet built several small boats in 1885 to 1890 with a propeller which worked on a universal joint so arranged that the direction of thrust could be changed to drive the boat under water or to bring her to the surface. This propeller took the place of the usual vertical and horizontal rudders.

Professor Josiah L. Tuck built in 1885 a vessel called the *Peacemaker*, the novel feature of which consisted of a "caustic soda" boiler for generating steam for submerged work.

In 1886 a Mr. Waddington, of England, brought out a small electric accumulator boat with downhaul screws arranged in vertical tubes. He also used side rudders to assist in control of depth. It is reported that this vessel functioned quite successfully, but she was abandoned and Mr. Waddington does not seem to have developed anything further.

In 1882 George H. Baker brought out an egg-shaped vessel which he ran submerged by the use of side propellers driven by bevel gears. These propellers were carried in frames so that they could be inclined to exert a thrust downward or upward, or at any desired angle so as to pull the boat downward and drive her forward at the same time. This was an improvement over Nordenfelt's side propellers, which ran on fixed vertical shafts. This vessel functioned fairly satisfactorily at slow speeds, but neither the form nor driving mechanism was suitable for the higher speeds required by modern practice.

A number of other boats were built, but there does not appear in them to be anything new in principle. This brings us up to 1893, when the United States Government made an appropriation of $200,000 (£41,000) for a submarine boat and advertised for inventors to submit designs.

(To be continued.)

The Largest Hopper Bucket Dredger

The largest of three somewhat similar dregders which Messrs. Lobnitz & Co., Ltd., of Renfrew, Scotland, have supplied to the Suez Canal Company for service in the Port Said roads, where the working situation is very exposed and the dredging hard and difficult, is the *Penelope*, a vessel with a length of 309 feet, a breadth of 47 feet, and a depth of 29 feet 2 inches. The dredging machinery is of the most approved type, and there is an independent engine direct geared to the top tumbler. The twin screw propelling machinery is independent. All the gearing has machine-cut teeth. The bucket ladder is fitted with patent elastic gear for facilitating dredging in hard ground in a seaway.

An interesting feature of the equipment is the adoption of a Lobnitz lubricated bottom tumbler, a device first fitted to the North Eastern Railway Company's dredger *David Dale*, now in service at Hull. The *David Dale* has still her original bottom tumbler shaft in use after eight years' hard work, and we understand that the wear is so little that the shaft is still as serviceable as when new. Without this device the *David Dale* would have required more than a dozen new shafts, so that the saving on such a large machine, in time and in outlay for repairs, is very great. The same device has since been fitted by the North Eastern Railway Company to several of their dredgers, and it has also been adopted on the Panama Canal, by the Clyde Trust, and elsewhere.

The hopper door gear and shoots of the *Penelope* are worked by hydraulic pressure, all the doors being independent.

COMMERCE THROUGH THE SOO CANALS.—According to reports of the United States engineer in charge of the United States canal at Sault Ste. Marie, Mich., the number of passages both east and west bound through the American canal since its opening on April 17 up to May 31 was 2,336, and the net registered tonnage 6,446,872, as against 1,772 passages and 3,555,756 tons for the same period a year ago. For the Canadian canal the figures for 1915 were 659 passages and 833,219 tons, as against 918 passages and 2,791,675 tons for the corresponding period in 1914. In 1914, however, both canals opened on April 20, while in 1915 the United States canal opened on April 17 and the Canadian canal on April 13. As the commerce passing through these canals consists primarily of through business, these figures furnish a key to the water-borne trade of the Lake Superior section of the United States and Canada.

Auxiliary Naval Vessels

Classification of Naval Vessels—Description of the Destroyer Tender Melville

The great variation in the composition of groups and types of vessels in the naval establishment of a first class power may, perhaps, be conceived by scrutinizing the list appended below, comprising, it is believed, all the units as they would appear in active service:

A.—Fighting Ships.
- (1) Battleships of the first line.
- (2) Battleships of the second line.
- (3) Armored cruisers.
- (4) Cruisers of the first class.
- (5) Cruisers of the second class.
- (6) Cruisers of the third class.
- (7) Destroyers.
- (8) Torpedo boats.
- (9) Submarines.
- (10) Gunboats.

B.—Coast and Harbor Defense Ships.
- (1) Monitors.
- (2) Coast defense ships.

C.—Dispatch Ships.
- (1) Scouts.
- (2) Converted yachts.

D.—Auxiliary Ships.
- (1) Supply ships.
- (2) Hospital ships.
- (3) Oil fuel ships.
- (4) Colliers.
- (5) Transports.
- (6) Mine layers.
- (7) Mine sweepers.

E.—Miscellaneous Ships.
- (1) Tugs.
- (2) Coal barges.
- (3) Ash lighters.
- (4) Water barges.
- (5) Ammunition lighters.
- (6) Freight lighters.
- (7) Floating workshops.
- (8) Floating derricks.
- (9) Garbage lighters.
- (10) Ferry boats.
- (11) Mud scows.
- (12) Dredges.
- (13) Diver barges.

The vastness of the scope for administration, operation, design and construction covering such a complexity of units, will be conceded when a little thought is bestowed on the fact that each type of the vessels enumerated represents an individual design made to fulfill a given purpose and to perform a certain predetermined work during operations.

Under the name "Supply Ships" as given in the list, there are to be found two separate more or less distinctive classes, viz.:

A. Tenders for submarines.

B. Tenders for destroyers.

Of the former type of recent construction the submarine tender *Fulton* was described in the issue of July, 1914, of this journal, and as representative of the latter class the present article will deal with the destroyer tender *Melville*.

It is a well-known fact that the dimensions of destroyers or submarines are as yet not of such proportions as to render them independent in their actions for any length of time, when cut off from access to supply depots. It might properly be mentioned that as a result of the limited capacity of such vessels, together with the very exacting demands placed upon them in service, the construction of tenders or supply ships was essentially born.

In the presentation of a description of ships belonging to the naval service, the indulgence of the reader is hoped to be cheerfully forthcoming for omissions of data pertaining to different arrangements on the ground of their military importance.

The liberal policy of the United States Navy Department in permitting the publication of facts of technical value pertaining to naval construction must be appreciated, when consideration is given to the fact that the entire foreign engineering press at present is practically closed for any purpose of giving information of matters pertaining to marine engineering.

Service Characteristics

As the service intended to be performed by ships coming under this class of vessels is to supply munitions of war, provisions and stores, the interior arrangements are made primarily with a view to meet this purpose. There are also arrangements made on board to care for a large number of sick or otherwise incapacitated.

Among the supplies which a tender will be called upon to provide we find the following:

A. Air, compressed and carried in flasks.

B. Ice and refrigerated supplies.

C. Light and electric current.

D. Fresh water.

E. The output from machine shops for necessary repairs.

F. Hospital service (for which provision of 38 beds has been made).

Besides machinery and output for the supply of foregoing necessities, storage is provided for torpedoes, mines and ammunition, meats, stores and provisions.

General Features

The general appearance of the new destroyer tender *Melville*, as shown in Fig. 1, with its two masts and straight stem, somewhat resembles an ocean liner, but becomes distinctly military in the light of the batteries, consisting of eight 5-inch 51 caliber rifles and two 3-pounder saluting guns.

The general dimensions and data pertaining to the ship are as follows:

Length between perpendiculars	400 feet
Breadth	54 feet 5½ inches
Depth	20 feet
Displacement (normal)	7,150 tons
Oil fuel carried	900 tons
Speed, in knots	15
Total horsepower, main turbines	4,000
Number of shafts and screws	One
Type and number of boilers	Two B. & W.
Total heating surface, square feet	7,000
Three generating sets, 100 kilowatts each	125 volts
Total complement of officers and crew	254
Name of builders	New York Shipbuilding Company

Launched .... March 4, 1915
State of finish .... 90 percent
Cost of vessel, complete $1,310,000 (£268,000)

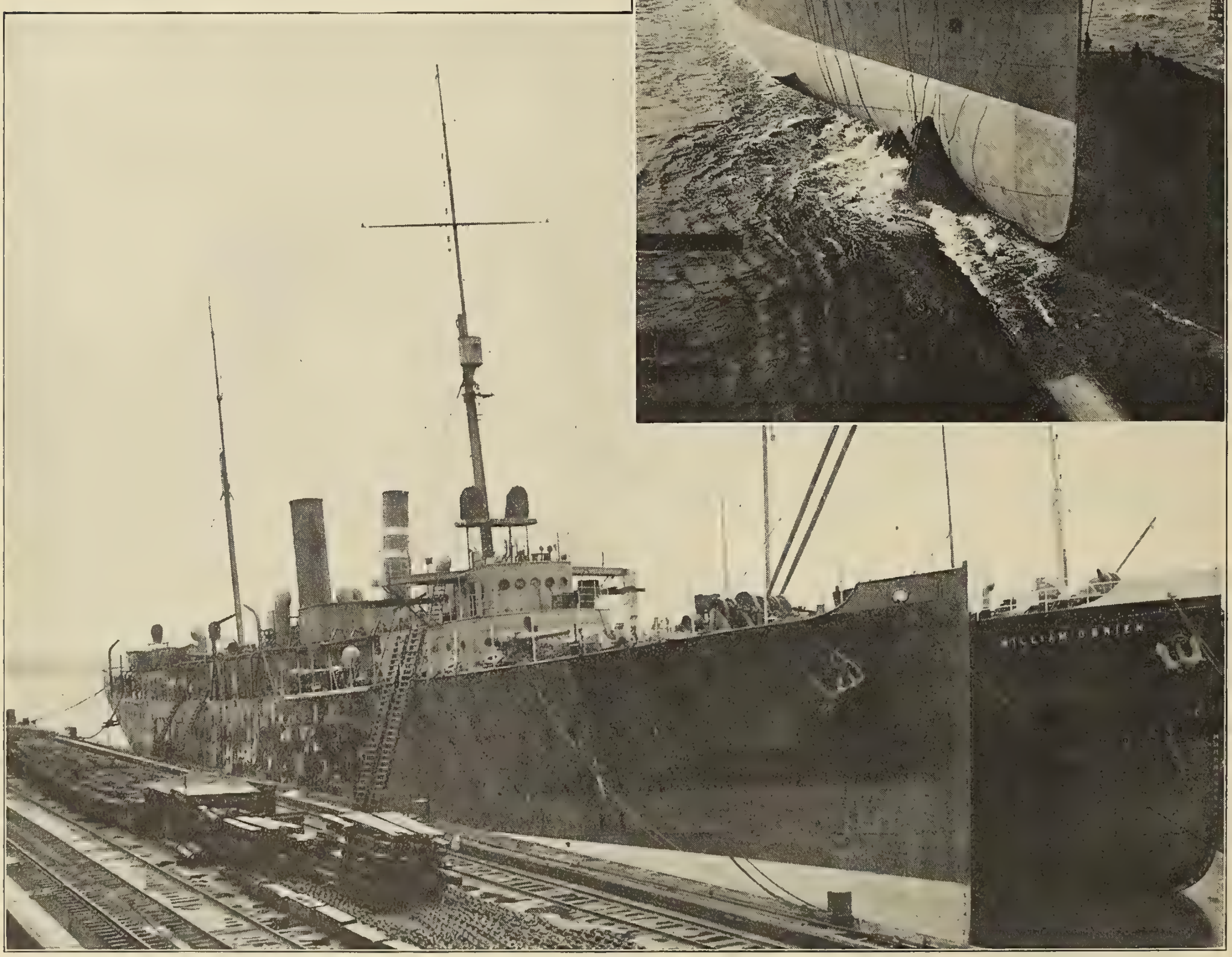
General Hull Arrangement

There are three principal decks, consisting of main deck, second and third deck. Below these decks forward is placed a platform deck which extends aft as far as possible and also partially amidships. Below the platform deck is the hold, divided into suitable compartments, among which are trimming tanks, hold space, stores and space for any provisions. On the deck spaces above are to be found special storerooms, cold storage rooms and magazines, officers' quarters aft and crew space forward. On the main deck are located three deck houses. In the forward deckhouse are arranged, besides the commanding officer's cabin and office, executive offices and navigating officer's stateroom. Similarly in the after deckhouse there are located the junior officers' staterooms and the flotilla commander's office and cabin. Within the deckhouse placed amidships there are situated the engine room hatchway, coppersmith and blacksmith shops, a foundry, the general storekeeper's and paymaster's office and a trunk for the smoke pipe, together with various other smaller compartments.

Machinery Arrangement

The driving power in this ship is developed by steam turbines, while in the submarine tender *Fulton* the corresponding power is produced by a Diesel engine.

The engine room is divided below the main deck into three compartments of which the center compartment constitutes the turbine room, while each wing compartment constitutes an auxiliary engine room. There are located in the starboard engine room three ice machines, the auxiliary condenser, and, above on a gallery, the generators with switchboard. In the port engine room below the gallery are to be found the main condenser, the main air and circulating pumps and feed tanks, and on the



(Phhotographs by the New York Shipbuilding Company)

Fig. 1.—U. S. S. *Melville* Fitting Out at the Builder's Yard

Fig. 2.—Launch of the *Melville*

gallery four double effect evaporators, together with the necessary pumps.

Forward of the engine compartment is the boiler compartment, where are placed, besides the boilers, fuel oil settling tanks, pumps and blowers.

The capacity of the evaporating plant is about 25,000 gallons for each twenty-four hours, and each of the three ice machines will yield 3 tons of ice every twenty-four hours. The three turbo generators are each of 100 kilowatt capacity.

There are placed in the machinery spaces numerous

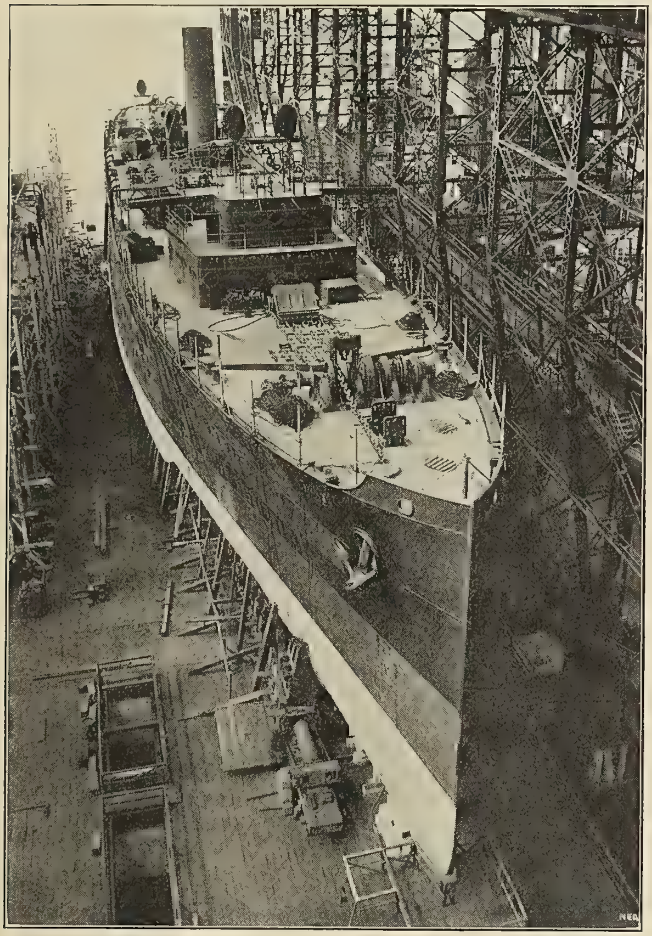


Fig. 3.—U. S. S. *Melville* on the Ways Previous to Launching

other auxiliaries, such as the main and auxiliary feed pumps, fire and bilge pumps, lubricating oil pumps, evaporator feed and fresh water pumps, fuel oil supply pumps and burner pumps. The distillers are placed at a higher level in the engine room hatch.

The turbine machinery is of Parsons type and consists of two separate turbine units, of which the high-pressure unit is placed on the starboard side and the low-pressure unit on the port side of the ship.

The transmission of power from turbines to the propeller is effected by means of a Westinghouse mechanical reduction gear, consisting substantially of a pinion on each turbine shaft meshing with a gear wheel attached to the center shafting driving the propeller. The propeller revolves at a speed of 110 revolutions per minute, while the turbines run at 1,400 revolutions. The speed of transmission is thus reduced in a ratio of 140 to 11, or nearly thirteen times.

The gearing is of the double spiral type with the teeth of each cut in the opposite direction. Each pinion transmits 2,000 horsepower, and being of the same diameter, revolves at the same speed, viz., 1,400 revolutions per minute. The gear wheel center is made of cast iron, the rim of cast steel and the shaft of mild steel forging, while the pinions are made of rather high grade steel forgings and the pinion driving shafts of chrome nickel steel. The angle of the spiral is about 30 degrees and the width of face is 16 inches for each single gear, making a total width of driving face of 32 inches with 40 tooth contact points with a contact pressure of 562 pounds.

The general advantages claimed for transmission of the propulsive power by means of reduction gearing as compared with straight turbine drive are:

1. About 15 percent increase in the economy of coal consumption.

2. Average reduction in the weight of the machinery about 15 percent.

3. The reduction in the size of turbine rotors, which is of practical advantage in handling, as well as general reduction in the size of turbines.

To meet the requirements for successful operation, the gearing must be durable, practically noiseless with the transition of pressure from tooth to tooth without shock.

The bearing supports of the pinions for mechanical gearing are made sometimes rigid and sometimes with floating arrangements, both of which have given satisfaction. The Westinghouse gearing is provided with a hydraulic floating arrangement for each pinion, and is now made for several United States vessels.

Steamer Emblane

A unique vessel designed by George Owen, naval architect, of Newton, Mass., for special service in experimenting with and testing the torpedoes built by the E. W. Bliss Company, Brooklyn, N. Y., has recently been completed by the Bath Iron Works, Bath, Me. The vessel, known as the *Emblane*, is 130 feet 7 inches long overall, 125 feet long between perpendiculars, 31 feet 6 inches extreme beam, with a draft of 6 feet on a displacement of 308 tons.

Fig. 1.—Torpedo Testing Steamer *Emblane*

The home port of the *Emblane* is Sag Harbor, at the eastern end of Long Island. From Sag Harbor she makes daily runs to her moorings on the torpedo range in Gardner's Bay, where the torpedoes are tested on the long range of 12,500 yards, or a little over seven miles. After the day's work, the *Emblane* returns to Sag Harbor.

The general arrangement of the steamer and the principal scantlings of the hull are shown in Figs. 2 and 3. Propulsion is by a three-cylinder, triple expansion engine, designed and built by the Bath Iron Works. The cylinders are 8, 13 and 21 inches diameter by 15 inches stroke.

Steam is supplied by two Almy watertube boilers at 250 pounds pressure. The boilers are oil-fired by the White system, and the oil is carried in large tanks of sufficient capacity to supply two weeks' continuous use.

The main condenser is the Bath Iron Works expanded tube type, the circulating pump a Kingsford centrifugal pump and the feed and donkey pumps of the Blake type. The auxiliaries also include a 7-kilowatt General Electric generator, which, in conjunction with a 100-cell Edison storage battery, provides efficient lighting for the steamer. Steering is by a Hyde steam steering gear located in the engine room.

In the large center compartment in the hold are two air compressors made by the Laidlaw-Dunn-Gordan Company, which, through an elaborate system of piping, compress air to a pressure of 3,000 pounds per square inch. This compressed air is stored in air flasks and is used as the propelling medium for the torpedoes. The large center compartment in the hold also contains the fuel oil tanks and reserve fresh water tanks.

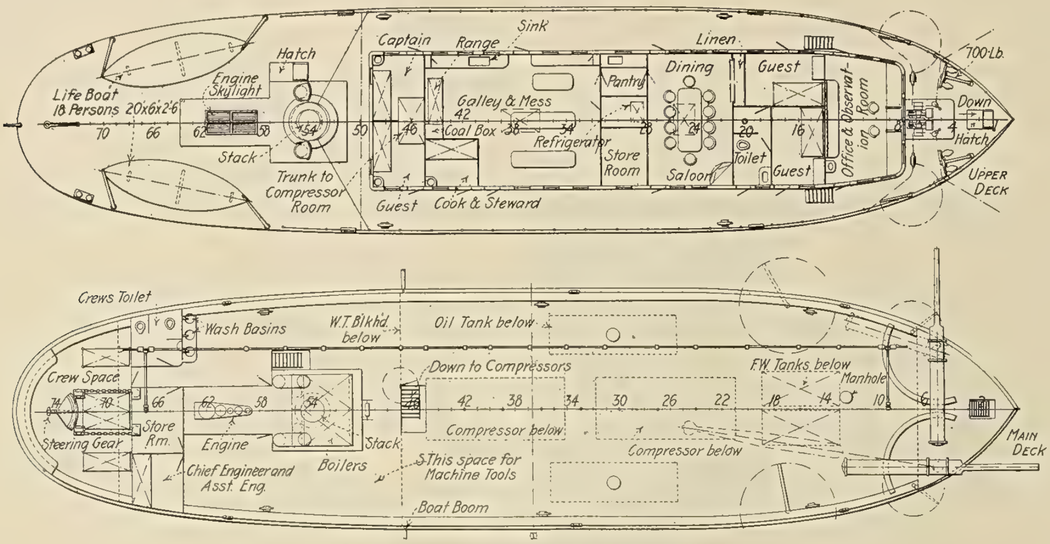


Fig. 2.—Deck Plans of the *Emblane*

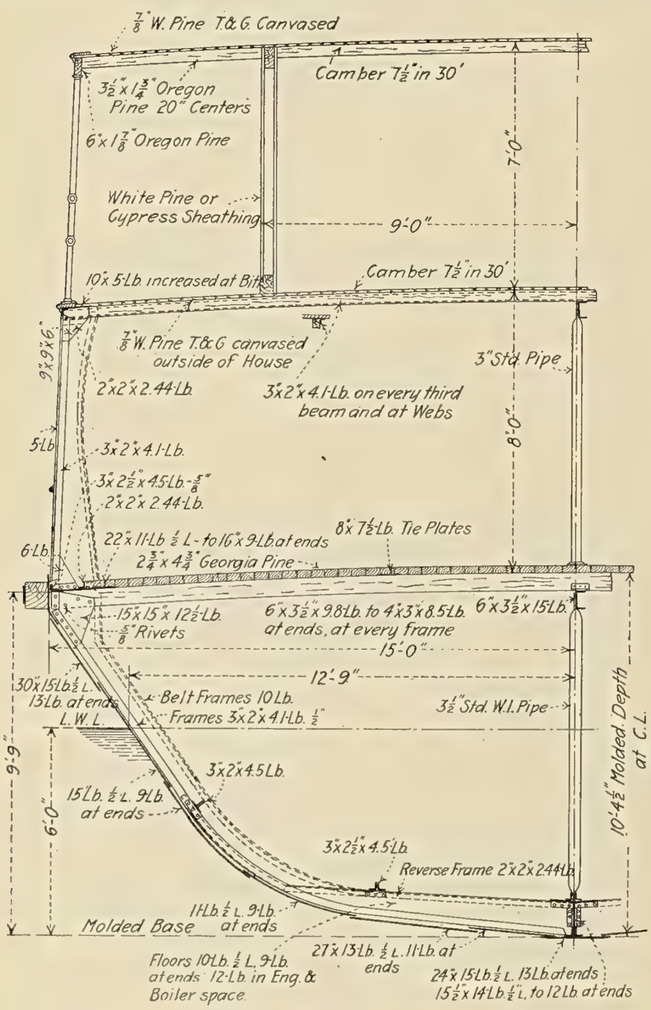


Fig. 3.—Midship Section

Forward on the main deck are two torpedo launching tubes with space for storing twelve to eighteen torpedoes. Aft on this deck are the crew's quarters and rooms for the mate and assistant engineer. On the upper deck, forward, are the observation cabin, two staterooms for guests, a guests' dining room, pantry and galley and the crew's messroom, as well as staterooms for the captain and chief engineer. A crew of thirty-six men is carried.

Although the maximum speed of the *Emblane* was estimated as eleven statute miles per hour, yet on her official trial trip over a measured mile course she attained a maximum speed of 11.23 statute miles per hour, the engines developing 260 indicated horsepower at 245 revolutions per minute. On her run from Bath, Me., to her home port, Sag Harbor, Long Island, a distance of 321 statute miles, the *Emblane* averaged a speed of 10.98 statute miles per hour, although this was her first run after her trial trip, and was made in a very rough sea.

In the design of this steamer appearance was necessarily subordinated to the specific demands for her service as a work boat for handling large and heavy torpedoes, for which she has proved very efficient, yet her type, with a few modifications, would make a most excellent houseboat, or small freight and passenger steamer for inland waters. The construction of the vessel was supervised by George Owen, her designer.

Illinois River 8-Foot Waterway.—The Illinois State Legislature has recently passed a bill providing for a waterway of 8 feet draft connecting the Chicago drainage canal at Joliet with the Illinois River at La Salle, a distance of 65 miles. The work will be partly river improvement and partly canal and will probably be completed in two years, forming a link in the Lakes and Gulf waterway.

The Marine Terminals of Beaumont, Texas

Development of 55 Acres of Land and Water Areas for an Industrial Terminal on the Nechez River

BY H. MC L. HARDING *

Texas has an enormous hinterland, rich in the fertility of its soil, agricultural products and mineral resources, and rich in its peculiar energy-producing climate, but its harbors for ocean-going ships are few in number. Along much of its coast there is little deep water, for the Gulf of Mexico near the coast is shallow and generally for a distance of half a mile from the shore there is a depth of only six feet at low water.

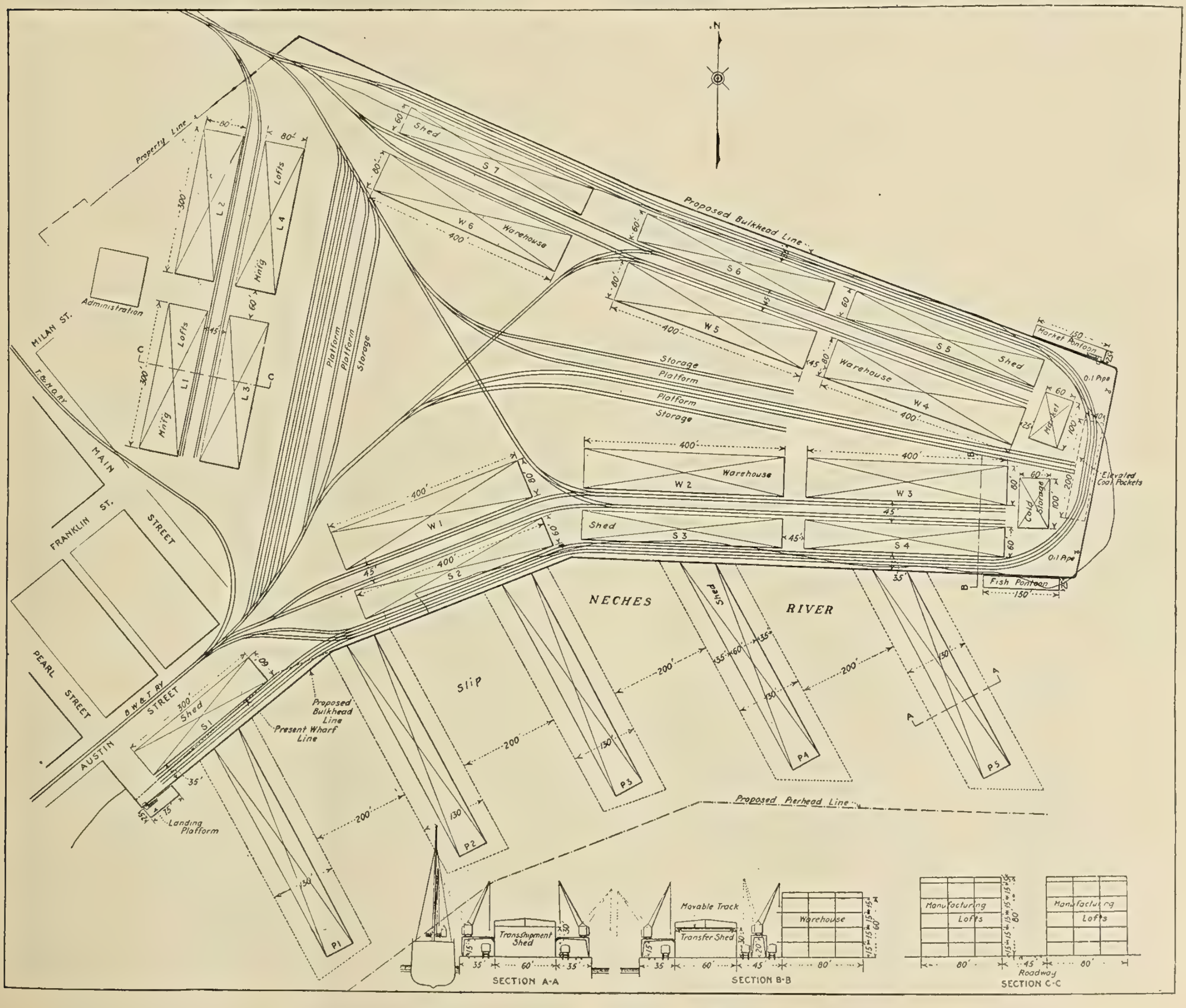
There are, however, a few deep water channels extending inland, one of which is the Nechez River. On this river, about fifty miles from the Gulf of Mexico, is the harbor of Beaumont. Beaumont is within the eastern portion of Texas, and its port will serve an extensive area, larger than that of the New England States. There is a channel about 25 feet in depth from the Gulf to the quays of the city, and a turning basin, dredged in front of the quays, and even now its area is greater than the Thames at the port of London. When the dredging now going on is completed, this turning basin will be in the form of an oval, the dimensions being about one-half by one-third of a mile. The city was fortunate in being able to secure a large plot of land within a thousand feet of the court house, called "Kirby Point," around three sides of which flows the Nechez River. With the land and water areas there are available about fifty-five acres for an industrial or local terminal.

* Consulting Engineer, 52 Vanderbilt avenue, New York City.

Commerce Terminal

On the other side of the river bordering partially on this basin is another area of hundreds of acres of sufficient size for a commercial or through-freight marine terminal for all of Texas.

Here will be established a large railway service yard, comprising the receiving, classifying and storage tracks, a transfer station, and large cotton, rice and other warehouses, both for outbound and inbound cargoes, as well



Arrangement of Beaumont Marine Terminals, Showing Proposed Piers

as large open spaces for the storage of coarse and bulk freight not affected by climatic conditions. The dry docks of the port will later be built here.

Much of this land, being low lying, is admirably adapted for a commercial terminal, being much preferable to places where there are high banks.

Industrial Terminal

The industrial terminal, of which the plan and sectional elevation are here given, is designed to be constructed on the unit system. A unit length of quay is equal to 500 feet, which is the length of a large freighter, such a unit being provided with a proportional length of shed, warehouse, necessary railway tracks, and also the transferring and handling machinery. A second unit can be installed without requiring any changes in Unit No. 1 or interruption of traffic.

Each unit complete, including the above elements with the dray area, the filling and paving, will make this total investment, without the land, of about $300,000 (£61,500). The seven units with the fish and farm markets, the cold storage and administration buildings, the manufacturing lofts, sheds, railway approaches and storage tracks, will require an investment of about $3,000,000 (£615,000)

Additional units will be constructed according to the demands of traffic.

Mechanical Transference and Handling

As will be seen from the elevation, freight is transferred by the traveling gantry jib cranes, either to the car, to the quay or the shed, and by the overhead traveling hoists and movable tracks will be assorted, distributed and tiered in the shed, and by other cranes, which will be at the rear of the shed, freight is transferred by one direct movement from the shed to any story of the warehouse.

Belt Railroad

All the important trunk lines of Texas converge towards Beaumont, and the new lines projected will tap other States to the north of Texas. By means of the terminal railway tracks and the present belt line railroad, cars can be switched between any of the railroads entering Beaumont, and any shed, warehouse or storage place within the terminal. The railway tracks are between the shed and the waterway and between the shed and the warehouse, thereby affording complete co-ordination.

Projecting Piers

At first along the river banks of the terminal there will be constructed only the concrete quay walls. Later the projecting piers will be added according to the increase of the tonnage.

For the present and future development of the industrial terminal there will be, beside that area mentioned, about 325,000 square feet of pier space, 575,000 square feet of slip space, and 60 acres in addition in the turning basin. There will be 9,275 feet of lineal frontage, over which, when mechanically equipped with the latest appliances, and intensively worked, there can be transferred annually over 3,000,000 tons of miscellaneous cargoes.

This lineal frontage will be utilized as follows: Discharging and loading berths for 13 ships, each 500 feet in length; 1 ship, 450 feet in length; 2 ships, each 300 feet in length; 3 ships, each 150 feet in length; 3 ships, each 125 feet in length; total, 22 ships.

Other quay wall frontage between the piers will be reserved for barges, lighters, river craft and for smaller vessels.

The seven transfer sheds on the quays and the five trans-shipment sheds on the piers will be of steel and will have a total holding or short-time storage capacity of 114,500 tons. In the concrete warehouses there will be a long storage capacity of 150,000 tons. The open storage spaces for outside freight will amount to approximately 300,000 square feet, while the concrete manufacturing lofts will have a combined floor area of 620,000 square feet. There will be an administration building, the farm and fish markets and cold storage building. Coal pockets and oil pipes are located where vessels can be supplied with the least discomfort to the remainder of the terminal.

Freight Movements

The principal freight movements will be between the vessel and the pier, quay, shed, car, dray or large motor truck, and also between the shed and car and the different stories of the warehouse, all of which movements will be effected by machinery.

Cranes and Other Machinery

The following are the characteristics of the traveling gantry jib cranes.

Two types of cranes are used, one the half arch and the other the full arch.

Normal load, 3 tons.

Over-reach, 45 feet.

Horizontal distance between crane tracks, 32 feet.

Maximum height of lift, 70 feet.

Lifting speed, 3 tons at 150 feet per minute.

Lifting speed, 1½ tons at 200 feet per minute.

Motive power, electricity, direct current, either 550 or 220 volts, D. C.

Fifty or sixty cycles or drafts per hour.

There will also be transfer bridges for lumber and structural steel, and conveyors for special commodities.

In the sheds will be overhead traveling transfer cranes and electric traveling hoists with a hoisting and carrying capacity of two tons each, for the assorting, distributing and tiering of miscellaneous freight. The hoists will be operated in trains. For long movements, motor trucks will be used.

The quay walls above low water will be composed of concrete. This type of wall with no wood entering into the construction except that which is below low waterline, which, being always wet, is decay resisting and fireproof.

It is expected that the first unit will be completed and ready to add to the capacity of the present wharves within the next few months.

Development of Auxiliary Sailing Ships

New York harbor was recently visited by the Norwegian auxiliary sailing ship *Elfleda,* owned by the Trans-Atlantic Motor Ship Company, Ltd., of Christiania, Norway. The *Elfleda* is a square-rigged vessel 226 feet long, 36 feet beam and 21 feet 9 inches depth, with a gross tonnage of 1,240 tons and a deadweight carrying capacity of 1,900 tons. The auxiliary power plant consists of two 120 horsepower Bolinder oil engines driving twin screws. On her voyage across the Atlantic to New York the vessel averaged a speed of 9 knots, the total fuel consumption for the entire trip being 12 tons. The guaranteed maximum fuel consumption of these engines is .58 pound per brake horsepower per hour, which, with oil at 3 cents (0/1½) per gallon, means a cost per hour of only 55 cents (2/3½).

Two other auxiliary sailing vessels equipped with Bolinder engines are owned by the Trans-Atlantic Motor Ship Company, Ltd. One of these is the *Fingal,* 308 feet long, 42 feet beam and 24 feet depth, with a deadweight carrying capacity of 3,900 tons. She is equipped with two 160 horsepower Bolinder engines. The other is the

General View of Locks and Dam No. 17 on the Black Warrior River, Ala.

Lota, 232 feet long, 37 feet beam and 21 feet 6 inches depth, with a deadweight carrying capacity of 2,100 tons. Like the *Elfleda* she is equipped with two 120 horsepower Bolinder engines, although she is about 10 percent larger.

This company has also recently purchased five other sailing vessels, which will also be equipped with Bolinder engines for auxiliary power.

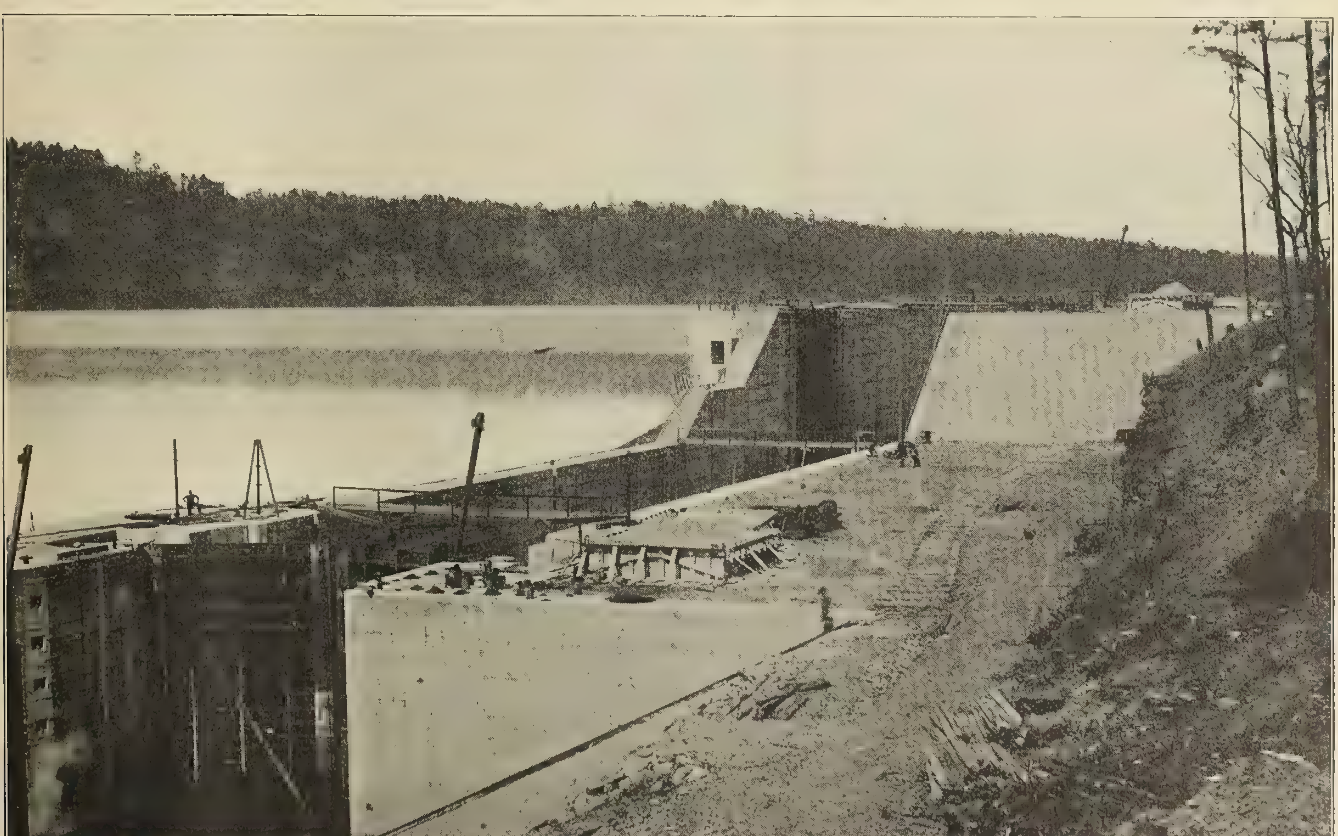
Completion of Locks and Dam No. 17 on the Black Warrior River

The locks and dam No. 17, which are the key to navigation of the Mobile, Tom Bigbee and Tuscaloosa rivers between Mobile, Tuscaloosa and the Alabama coal and mineral fields, were officially opened on May 13. The completion of these locks will enable coal, iron and other products to be transported to Mobile for about 65 cents (2/8½) per ton.

Locks and dam No. 17 are located on Squaw shoals, Black Warrior River, Alabama, 26 miles north of Tuscaloosa, Ala., and 12 miles from Birmingham, Ala. What is known as Squaw shoals represents a fall of 40 feet in a stretch of about 4 miles, and this is more than overcome by lock and dam No. 16 and locks and dam No. 17. Lock and dam No. 16, with a lift of 21 feet, located at the foot of Squaw shoals, backs the water up to the base of the dam No. 17, a distance of 1½ miles. By means of channeling and excavating in the lower approach of locks No. 17 a channel 7 feet deep was obtained from dam No. 16.

Locks and dam No. 17 comprise a flight of two locks of 31½ feet lift each and a dam of 63 feet lift. They represent an expenditure of 3,000,000 (£615,000) by the United States Government and are the last of a system of dams and locks on the Black Warrior River, which altogether represent an expenditure of about $15,000,000 (£3,075,000). This system provides a channel 6 feet deep for slack water navigation the year round from Mobile to the coal and mineral fields of the Birmingham district.

The construction of these locks was in charge of Mr. G. K. Little, assistant engineer of the United States Army Engineer Corps, assisted by Mr. S. T. Jones, Jr., while the actual construction was carried out by B. H. Hardaway & Co., of Columbus, Ga., contractors. L. E. G.



Locks and Dam No. 17, Black Warrior River, Ala. View of Approach from Side Bank

Large Motor-Driven Railway Train Ferry

Description of an Unusual Vessel Built on the Pacific Coast for Train Ferry Service in San Francisco Bay

BY CHARLES J. BELDEN

Probably the most noteworthy motor-driven vessel outside of Europe has been completed recently in California, and is at the present time in continuous service. Both the hull and machinery equipment possess features of unusual interest to those who have followed marine engineering developments of the past few years, and the progress of this installation has been watched with considerable interest by Pacific Coast engineers.

The *Ramon,* as this vessel was christened, was built by the Oakland, Antioch & Eastern Railway and is being used to transport their trains across an arm of San Francisco Bay. The main line of this road operates between Sacramento and San Francisco, Cal., through the rich farming lands found in the deltas of the San Joaquin and Sacramento rivers, and the construction of the road over this low-lying country has necessitated building many miles of bridges and trestle work. At one point a considerable expanse of water had to be crossed, and it was decided that the most feasible way for negotiating this stretch would be to ferry the trains over on a boat. This method has been used for a great many years by the Southern Pacific Railway at a similar point in connection with their transcontinental line.

In considering the construction of a suitable vessel, the engineers of the road had three main considerations to take into account, namely, reliability, economy and time of delivery. Of course it might be said that the first two are the prime considerations for any marine installation, but they were of especial importance in the present case on account of the nature of the service for which the vessel is intended. Reliability was a vital point, as the schedules of the whole system would be upset by any interruption in the service of this boat, which, as stated above, was to operate at a point on the main line of the road. The relative economy of steam and internal combustion engines in intermittent service was carefully considered, with the result that the latter were adopted principally on account of the saving effected by this type of power between trips. It was also found that the use of distillate (paraffin) engines would reduce the size of the boat and the number of men necessary for its operation. The short time of delivery required for the complete installation was the consideration that influenced the design of the hull to a large extent, necessitating a departure from usual practice in order to expedite construction. The time factor also worked to the advantage of an oil engine equipment.

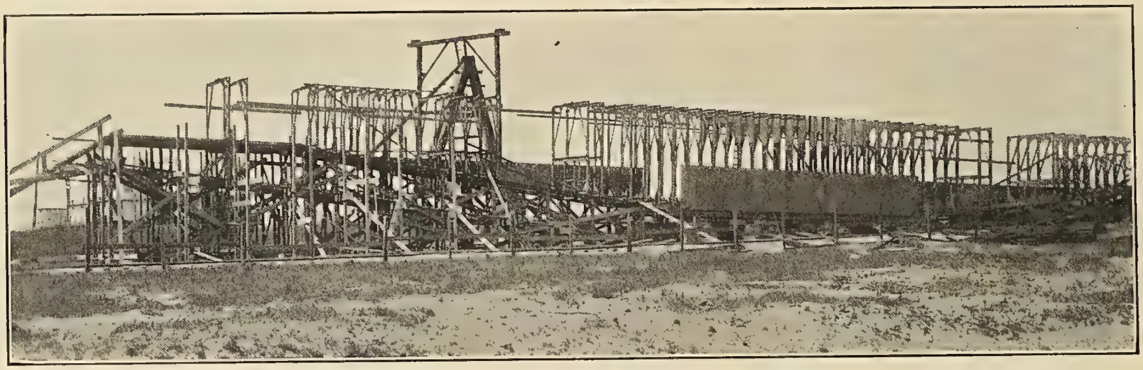


Fig. 1.—General View of the *Ramon* under Construction

The hull of the *Ramon* is built entirely of steel, which

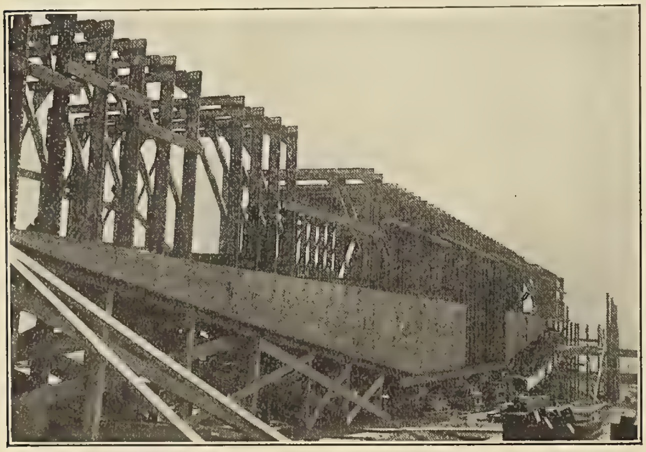


Fig. 2.—Central Girder Construction

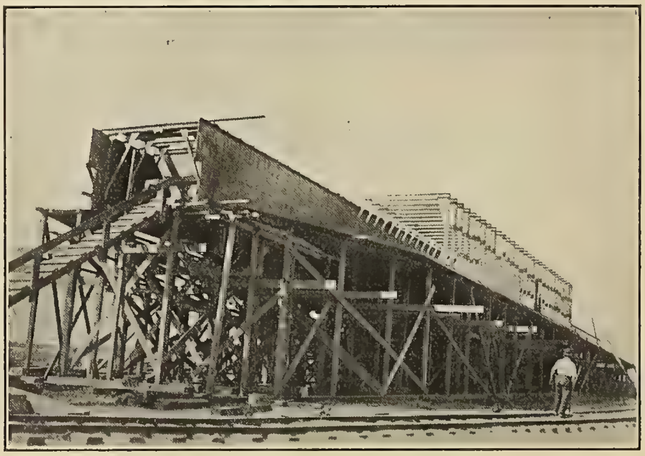


Fig. 3.—Construction on Either Side of Central Girder

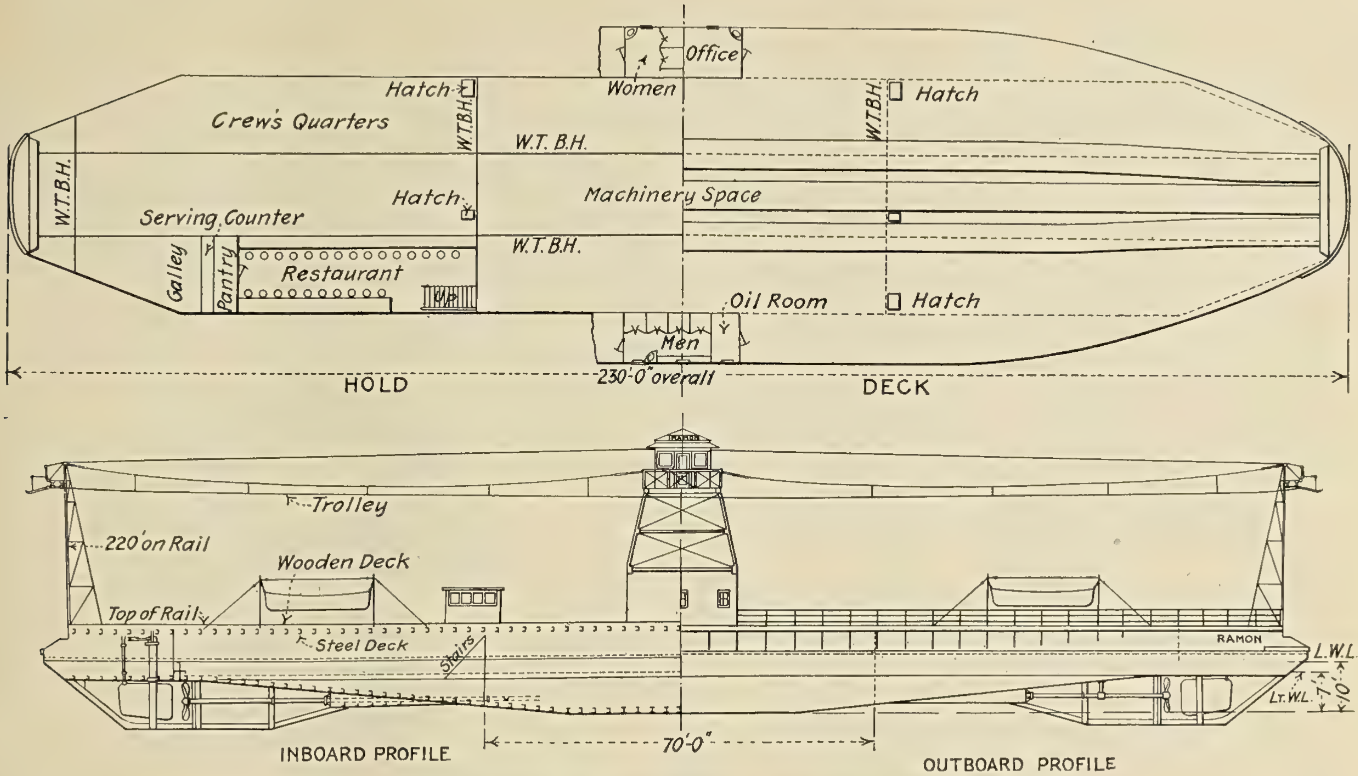


Fig. 4.—Deck Plan and Outside Profile of the *Ramon*

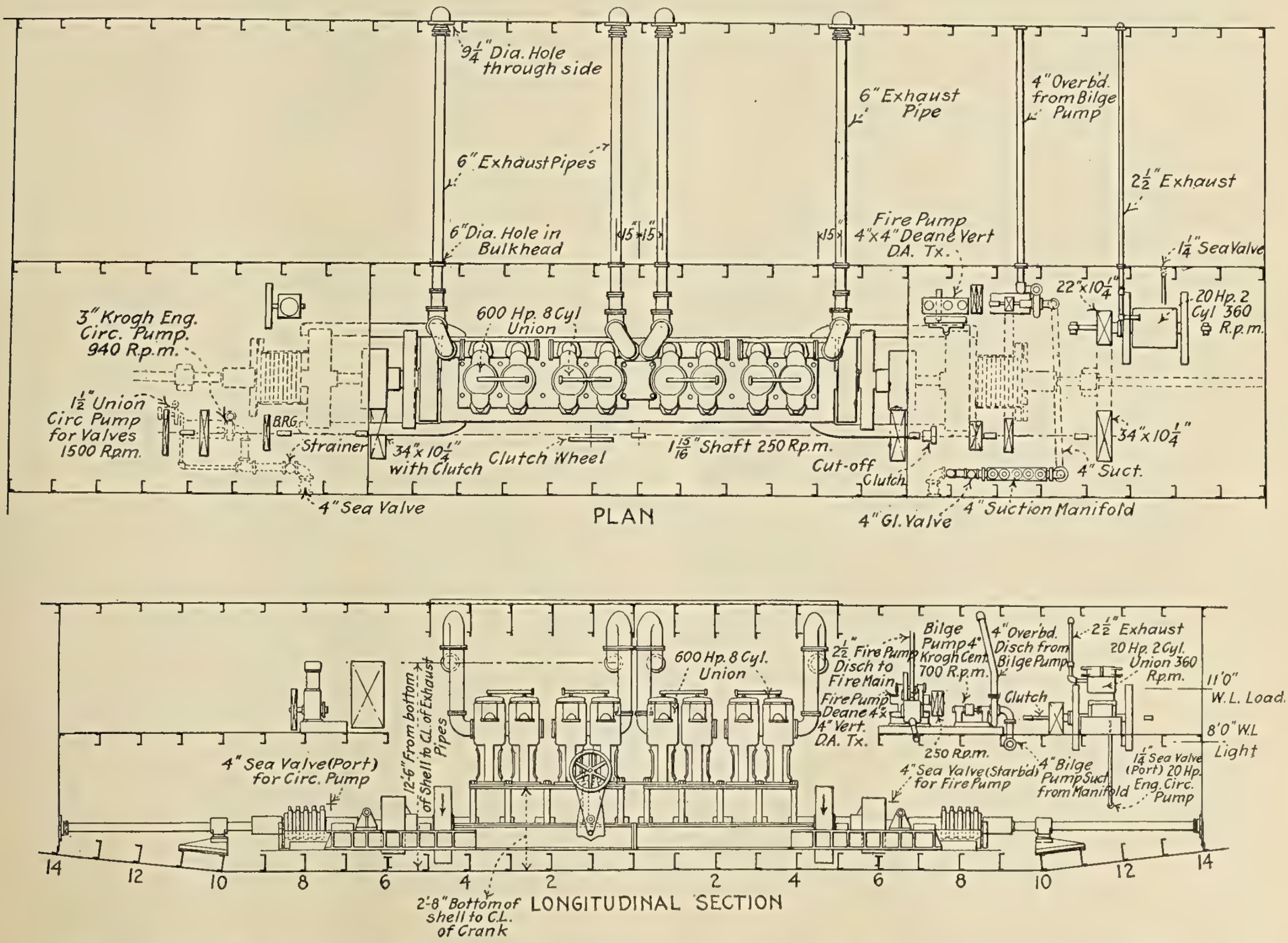


Fig. 5.—Engine Room Arrangement, Showing the 600-Horsepower, 8-Cylinder Distillate (Paraffin) Engine, Built by the Union Gas Engine Company, San Francisco

was manufactured by a local rolling mill and erected by the railroad company. The total weight of the steel used amounts to 320 tons.

The principal dimensions of the *Ramon* are as follows: Length over all, 236 feet; breadth, 58 feet; maximum draft, 12¼ feet.

On account of the short time allotted for the construction of the vessel all curved plates were eliminated and a box-like design was adopted which allowed for the use of flat plates throughout. The hull is built about a central girder formed by two longitudinal bulkheads extending the entire length of the boat, Figs. 1 and 2. In this way extreme longitudinal stiffness and general rigidity have been obtained. The engine room is located between these two bulkheads, thus providing an exceptionally stiff engine bed necessitated by the length of the engine—i. e., 46 feet. The fore and aft limits of the engine room, which is 70 feet long by 13 feet wide by 16 feet deep, are determined by two transverse bulkheads extending the entire width of the vessel. These two additional bulkheads divide the hull into eleven watertight compartments, making it well nigh unsinkable. At either end of the engine room is located an intermediate deck, on which the auxiliary machinery is located.

It will be seen from the side elevation that there are two deck houses which form the base for the pilot's bridge. These houses will contain toilets, a lamp room and cabin. The crew's quarters, galley and dining room, seating sixty people, are located below decks.

At either end of the boat there are two steel towers for carrying the trolley wires which make contact with the wires on the apron through switches controlled from the pilot house. The three tracks on deck will each be 220 feet long, accommodating a total of twelve passenger coaches. The rails will be flush with a wooden deck which will be laid over the steel deck, thus insuring the safety of passengers promenading while the boat is in transit. The propeller and balanced rudder on either end will be protected by a skag constructed of two 10-inch ship channels with a 10-inch by 16-inch timber between them.

Propelling Machinery

The propelling machinery of the *Ramon* possesses unusual interest, as it consists of the largest internal combustion motor of the electric ignition type ever built in any part of the world. This fact can be readily appreciated when it is stated that the completed engine will weigh approximately 100,000 pounds, its total length being 46 feet.

The engine is an eight-cylinder unit designed to develop 600 horsepower at a normal speed of 200 revolutions per minute. It is an "open crosshead type" engine, and its construction has been undertaken by the Union Gas Engine Company of San Francisco. This type of distillate (paraffin) engine is perhaps one that will not be familiar to British engineers, as it has been developed solely on the Pacific Coast. The open crosshead in this case is slightly different in design from that which obtains in steam and large Diesel installations, and consists of a water jacketed extension on the lower end of the cylinder which acts as a crosshead guide. The piston is exceptionally long, and the lower end, which holds the wrist pin, acts as a crosshead. There are openings fore and aft in both cylinder and piston, thus allowing a circulation of air about the wrist pin. The inlet and exhaust valves are disposed on either side of the cylinder in the familiar "T" head arrangement; the exhaust valves are water cooled. It will be seen from the profile of the engine room arrangement that the cylinders are grouped in four pairs to correspond to the four sections of the crank shaft.

The fuel that is to be used is known on the Pacific Coast as "engine distillate" and corresponds closely to British "paraffin." The vaporizing device consists of two carburetors used in connection with two jacketed inlet manifolds of special construction, heated by the exhaust gases in order to prevent condensation of the heavy fuel. Each manifold supplies four cylinders. Lubrication of the cylinders and bearings will be accomplished by means

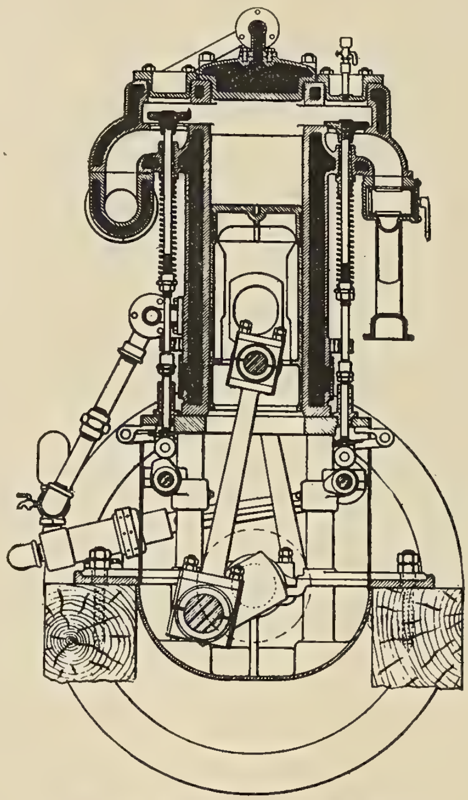


Fig. 6.—Cross Section of Engine

of force feed lubricators mounted on the back of the engine and driven from the cam shaft. The crank-pin bearings are lubricated by a centrifugal ring oiling device mounted on each crank web and connecting with oil holes leading out to the center of the crank-pin.

The engine is placed in the center of the hull, as shown in the engine room plan, and is connected to a four-bladed propeller, 72 inches in diameter, on either end. The *Ramon*, as stated above, is double-ended, and in order to eliminate the necessity of a reverse gear the two propellers are made of opposite pitch and are thrown in and out of action by a clutch mounted on each end of the engine. At one end of the engine room a 20-horsepower, two-cylinder, distillate engine is belted to a generator for supplying current for lighting purposes about the ship and also to the coaches in transit.

This installation of 600 odd horsepower will require only one engineer in the engine room, which will be a considerable reduction in the number required for a steam plant of equal capacity. The greatest saving, however, will be shown in the elimination of all fuel expense while the vessel is tied up at the wharf, and it is this consideration that will undoubtedly lead to the further development of the internal combustion engine for ferryboat service, especially about San Francisco Bay, where this type of vessel is used to a large extent.

Davits and the New Requirements*

BY HARRY W. BROADY †

Class D Davits

The pivoted davits, Class D, are the most numerous of all classes and there are now probably more than 2,000 patents granted for davits coming within this class—and more are being allowed all the time.

The simplicity of the theory of working, namely, only to swing a pivoted arm out, is very deluding. All the davits of this class have some very serious disadvantages. First of all, is the very excessive amount of power needed to swing a boat out or in, and therefore the attendant uncertainty of action in these davits under severe conditions. Each davit usually consists of an arm pivoted at its lower end to brackets fastened at the outer edge of the deck.

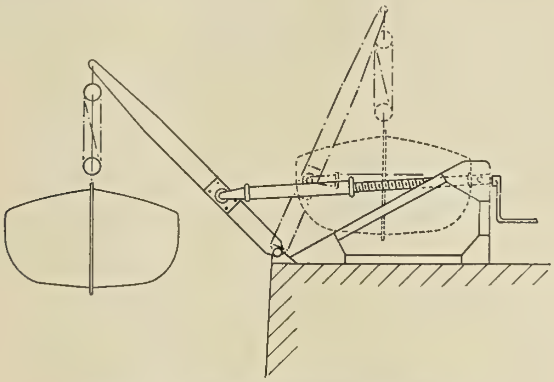


Fig. 6.—Norton Sheath Screw Davit

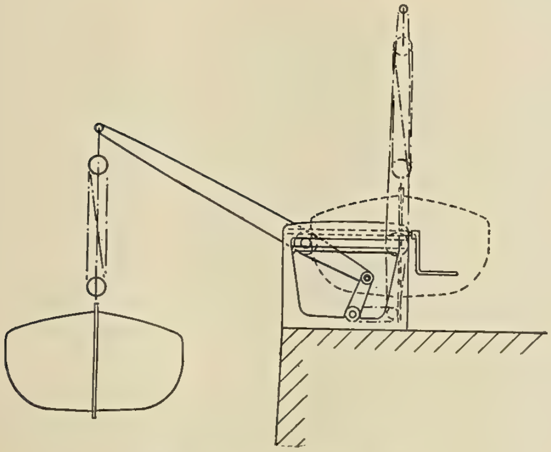


Fig. 7.—Hale Pivoted Davit

The arms must reach inboard so far that the upper end or eye is just above the centerline of the boat. The placing of the brackets as close as possible to the ship's side is necessary so as to give as short an arm as practicable.

The arms are swung in and out by means of some screw or link device which generally is connected to the arm about one-third of its length from the deck. This arrangement gives a considerable angle between the centerline of the arm in inboard position and the vertical through the pivoted point. This angle is the main determining factor in the power needed to move the davit out; thus the greater the angle, the greater the power required. There will always be a force in an inboard direction to be overcome, as long as the center of gravity of the system (boat and arm) is inboard of the pivoted point, and this force will effect a compression in the turning-out parts. The force to be overcome depends on the angle above referred to, the weight of the system, i. e., davit arms and boat, the length of the arm, and the direction and point of application of the parts for moving the davit out.

Under ordinary conditions the power needed for swinging the boat out is comparatively very great, even with the ship in an upright position. If the ship should take a list, and the passengers in a moment of panic should rush into the boat before it is launched, the power needed for turning out the boat would be so great that not enough men could find room to work the cranks to furnish the required power. There is usually room for only four men at each crank.

The possibilities of taking care of extra weight and possible list are so limited in this class of davits that they cannot be made dependable under extraordinary conditions, which, however, are not at all unlikely to prevail in case of disaster.

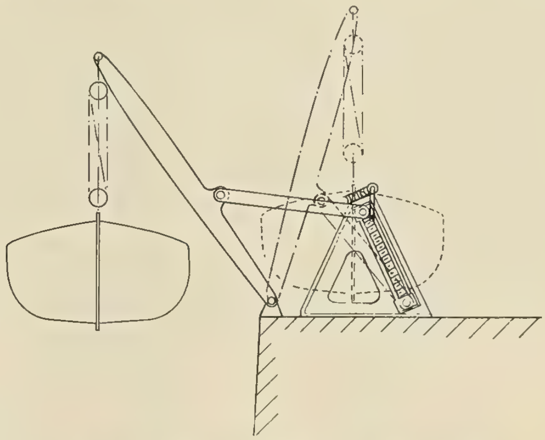


Fig. 8.—Broady-Lundin Link Screw Davit

Another serious objection to this class of davits is that they are, as a rule, very wobbly and unsteady. The arms are in most cases pivoted at their lower end, and have no other steadying support in their entire length. The necessarily non-rigid connection between the turning-out parts and the arm will not help at all to steady the arm; certainly not in the fore and aft direction and for twisting. The strain fore and aft is considerable, especially if the ship is pitching. All the davits must have an overhang in the fore and aft direction so that the boat will clear them when swung out. This overhang will, of course, cause a tremendous twist in the arms and also a strain tending to pull the arms together. The davits of this type will therefore be very unsteady unless they are made excessively heavy and very wide in a fore and aft direction at the pivoting point. This arrangement, of course, increases the weight and cost and also gives a very clumsy appearance.

A few davits of this class have been provided with guiding frames to steady the arms. The arm is in this case guided in a slot and slides against bare iron; this naturally helps to steady the arms, but the friction between the arms and the guides will be so great that the power necessary to launch a boat will have to be increased tremendously. It will very soon reach a point (especially on a pitching ship) where it is impossible to swing the boat out. This arrangement will also look very clumsy and add considerably to the cost of the davits.

Another objection to this class of davits is that they take too much deck space. The very long screw or link con-

* Continued from the June issue.
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nection makes it necessary to place its inboard support very far in. The deck space required for this class is therefore greater than for any other.

The vital part of a pivoted davit is the screw drive, of which there are two different types. One type is characterized by a swinging screw and the other by a rigidly supported screw. The screw in the first type is generally supported at its inboard end by either a swiveling or a stationary bearing in the deck frame, in which latter case it is provided with a universal joint between the deck frame and the threaded part. The screw actuates a nut connected to the davit arm. Only one end of the screw is thus supported, and the screw merely works in the nut. For working purposes there must always be a considerable clearance between the screw and the nut. This will give a very shaky and unsteady screw connection between deck frame and arm, as in most cases there are no other means provided for steadying this connection. This lack of rigidity is very dangerous when a boat is swung out, as the screw is subjected to compression during nearly the first half of the operation. The wear and tear of the screw connection will be very great, as the centerline of the screw and the nut will never coincide when under compression. The threads in the nut will therefore not afford any bearing surface for the screw, but will, on the other hand, cut the thread. To make it possible to turn the davits out, the threads are made comparatively fine. The wear and tear will therefore very quickly put a screw of this construction out of action, especially if all the boat drills required by the new laws are held.

Another danger is that as the screw is unsupported and entirely exposed when the davit is partly or fully swung out, the slightest blow from any direction will tend to bend the screw and thus put it out of commission. The screw is generally covered completely when the davit is in its inboard position, but as soon as the outboard movement of the davit begins the screw is automatically uncovered. The compression in the screw during the first half of the travel, owing to the loose construction, will be partly resolved into a force tending to bend the screw. Any outside blow will only tend to increase this ever-present difficulty, and it can easily be seen that an unprotected screw is very likely to be damaged by such a blow, especially from the lifeboat itself as it is swinging fore and aft. If this happens during the travel inboard of the boat, the serious results might not be noticed until the next time the boat is to be swung out. The length of the screw connection for a 26-foot to a 28-foot lifeboat is about 8 feet, and such a long connection increases the liability of damage even from the slightest blow.

The second type of screw drive is best illustrated by the link screw davits. The characteristics of these davits are that they have a strong, substantial link connection between the screw arm and the davit. The arms are generally of the same type as in all the others of this class, viz., their lower end is pivoted to brackets close to the side of the ship. The link is connected to the arm at about one-third of its height from the deck. The link is driven by means of a nut pivoted to its inboard end, which is worked by an actuating screw.

The screw connection in the link screw davits gives a very well protected and supported screw. The link takes up all the twist and bending of the arm. As the sliding nut moves on its substantial bearing surfaces in the frame, it relieves the screw from all side pressure. Only the forces along its centerline act on the screw, and it therefore works under the most favorable and effective conditions, and stands up very well.

Another favorable feature is that the link, during inboard position of the davit, is generally at right angles to the arm. The power needed to swing the davit out is therefore the minimum for this class—that is, the pivoted davit.

There are quite a number of different types of pivoted davits in the market. It is impossible to describe all of them, only a few can be briefly mentioned here.

One type of pivoted davit is the Broady davit, Patent No. 1,128,845. The main feature of this davit is the construction of the screw connection. A tube with an inside nut at its inboard end is connected to the arm. A screw, supported at its inboard end in a stationary bearing in the deck-frame, works in the inside nut in the tube. The screw is provided with an annular tubing which slides on the outside of the tube which carries the nut. The screw is provided with a universal joint between the deck frame and threaded part. When the screw device is worked the two sleeves or tubes work telescopically on each other. Thus there will always be a very rigid, well-protected screw connection. The bearing surfaces between the two working parts will at all times be very ample, especially when there is compression. The screw and the nut sleeve will never be out of line, and thus the screw will only have to act in an actuating and controlling capacity and will never be depended on to steady the connection; therefore there is no undue friction or wearing of the screw, due to the cutting action of the nut when not in perfect alinement. The screw is always protected by two strong tubes of large diameter. It will take a very hard blow to put this construction out of order. The serious objections generally found against the above-mentioned first type of screw drives are here fully overcome, but the disadvantages of the general principles remain.

The Broady-Lundin davit, Patent No. 1,105,594, is a link screw davit. This davit is characterized by its slanting screw, which is so arranged that when the davit is inboard the link is at right angles to the arm, and when the davit is outboard the link is horizontal. This construction requires much less power to operate in any direction than if the screw was placed in a horizontal position close to the deck. With the latter arrangement great power is required to swing the davits inboard, especially with a heavy boat hanging in them; this can be laid to the very unfavorable direction of the forces to bring the arm from an outboard position. A Broady-Lundin davit arrangement is shown in Fig. 8.

There have been some davits of Class D designed for big units of lifeboats; in some cases one set of davits had to take care of, say, five large 30-foot lifeboats. They were made of immense size and had therefore to be operated entirely by power. Davits of this type are large and cumbersome, the units too big, and the power uncertain in case of disaster. They must necessarily be heavily constructed and no doubt cost a good deal more than other davit arrangements. One set of davits in such a case must serve for many lifeboats, and the launching will necessarily go very slowly, as only one boat can be handled at a time. If one set of davits should be out of order, about 400 people would have to be taken care of in some other way. Something may very readily go wrong with the supply of power. Large power-driven units like these should only be used in extraordinary cases. The intention of the law-makers is very clearly shown in the stipulation of a minimum number of davits to take care of a minimum number of people. They have evidently decided that it is better to arrange for many easily operated smaller units than for a few big ones. The davits should be of such size and so arranged that they can be

Fig. 9.—Boat Drill on the Hamburg-American Liner *Imperator*, Showing Welin Quadrant Davits, with Boats Swung Outboard

turned out by hand, this being the only certain way. Of course, arrangements for power drive could be made in addition to hand drive.

The link screw davit is necessarily very high in price, owing to the many operating parts, and it is therefore very seldom used.

Several types of pivoted davits are shown in Figs. 6, 7 and 8. The davit shown in Fig. 7 is of special interest as being of a rather unique construction. The frame is very substantial and an improvement over the ordinary pivoted davit. The arm is entirely supported by a nut on which it hangs. This nut is guided in a slot in the upper part of the frame and is actuated by a screw above the slot. The arm is held in position at its lower end by a freely moving link connection.

Class E Davits

There are only two different types of quadrant davits, Class E. One is the Welin quadrant davit, Patent No. 680,823, and the other is the Schmidt davit, Patent No. 795,937.

There are many thousand sets of Welin quadrant davits installed on board ships to-day, and their number far exceeds that of all the other mechanical davits taken together. The general appearance of this type is familiar to all seafaring men and to others interested in the davit question.

In general, the construction of the Welin quadrant davit may be described as follows: A substantial square-shaped and broad-flanged frame is bolted to the deck. The lower part of the frame is provided with a toothed rack and a slot. The upper part is provided with an actuating screw turning in stationary bearings. Above the screw there is a rigid bronze-sleeved guide bar of ample dimensions. A nut, actuated by the screw, travels on the guide bar. The screw, guide bar and rack are all parallel and athwartships. The shape of the arm has given the davit its name. The lower part is a quadrant, provided with teeth and a flange, and works in the rack and slot of the frame. The upper part of the arm is curved somewhat in a fore and aft direction, to give the required overhang. The center of the quadrant is provided with a hole for the pin on the traveling nut; this nut holds the arm in position and also swings the arm when the davits are operated by turning the screw. The arm is arranged so that in its inboard position the upper end, or center of eye, comes slightly inside of the center of the quadrant.

This construction is very rigid and substantial without unnecessary weight. The arm is firmly supported both at its lower edge and at about one-third of its height upward by means of the strong rigid frame. The twisting and bending of the arm is thus reduced to a minimum and will not in any way affect the working parts.

The power required to swing the boat out is absolutely the minimum, as can be seen from the following:

The quadrant rolls on the flange in the slot and is controlled in its position by the toothed rack. There is, therefore, only negligible rolling and gear friction to overcome in the lower part of the arm. The nut slides on the rigid guide bar, the ample dimensions of which insure a large bearing surface to take care of all the stresses through the arm and minimizes the friction. The center of the radius of the quadrant is always in the centerline of the guide bar. Thus there can be no side pressure whatsoever on the actuating screw. The actuating screw is only sub-

jected to a thrust along its centerline, and can therefore be designed to give the best efficiency. It is generous in size, with large threads, the pitch always being so that it is self-locking, thus giving perfect control throughout the operation of the davit. Ample clearance can be given without detracting from its effectiveness. The actuating screw is very rigidly supported in the stationary bearings in the frame and also well protected from all blows by the upper part of the frame.

The very important working principle of the quadrant davit is that the force applied to the arm through the screw is always at right angles to the line between the center of the radius of the quadrant and the lower point of contact of the periphery of the quadrant with rack and slot. This will be the case in any position of the arm, and it is therefore generally called "the moving fulcrum" principle. The turning moment for the arm, under these conditions, will always be the maximum and always the same for all positions of the arm for the same amount of power applied.

Another feature helps to minimize the required power to swing the boat out: It is stated above that the hanging point of the arm (the eye), with the davit in the inboard position, is slightly inside of the center of the radius of the quadrant. Therefore, only a very short part of travel will require a very small outboard force; almost immediately the weight of the boat and arm will help the operation by changing the direction of the force in the screw. It is then only necessary to overcome all the friction, which is a very small matter.

The above shows why such a small amount of power is sufficient to launch even the largest lifeboats with the Welin quadrant davits; ordinarily only one man is needed at each crank. Even with a big list there will never be any uncertainty of action as far as turning out of the davits is concerned, as long as the list does not make it impossible for the men to stand on the deck to turn the cranks.

Another very important characteristic of the Welin quadrant davits is the compensation. By compensation is meant that the falls are led over sheaves so that the boat will get a more nearly horizontal path of travel than if the falls were led directly from the blocks to bollards or belaying pins. By this compensation, in some cases, a shorter arm than would otherwise be necessary may be used to give the proper clearance between boat and edge of deck, viz., with nested boats. Furthermore, the power required to swing the boats in is also reduced. From the following table can be seen the power needed on the crank to swing a lifeboat in or out, loaded and unloaded:

	Comparative Effort on Crank		
	Quadrant Lbs.	Pivoted Lbs.	Percentage
Boat in inboard position, empty...	8½	56½	Quadrant 15 percent of Pivoted.
Boat in inboard position, loaded..	23½	156	
Boat in outboard position, empty..	75	101	Quadrant 75 percent of Pivoted.
Boat in outboard position, loaded.	210	275	

Comparative figures are given for a Welin quadrant davit and a Broady pivoted davit. The same swing, outreach of davits and weights of boats are used. As nearly as possible the actual frictions and resistances for new davits are taken into consideration to give an absolutely fair comparison. The nature of the construction will to some extent affect the figures, such as the lesser rigidity of the pivoted davit. This cannot be accurately determined, but is none the less of great importance.

The open construction of the Welin quadrant davit is of great advantage in regard to upkeep and inspection; one can at a glance see if there is anything wrong with the driving mechanism. The question of the effect of ice on the operation of these davits has often come up. The only part where the ice could form on the davits in any quantity is in the rack, but it will never put the davit out of working order. The pressure of the sharp-edged flange and teeth will crush any ice because the pressure on the ice in the rack will be several thousand pounds per square inch. All the ice will press out or melt out of the rack. There are in a complete lifeboat and davit installation some parts that will much more readily be put out of order by ice than the davits. For instance, the necessary block and tackles. It is certainly safe to say that the davits would be the last parts of the whole equipment to be put out of commission by ice. This has been demonstrated many times in actual practice on board ships.

The deck space required for Welin quadrant davits is much less than for pivoted davits. The frames generally do not reach inboard further than about half the beam of the boat against at least the full beam for pivoted davits. The frames and arms are made of cast steel, as this requires less cost in upkeep, compared with structural steel davits. The weight will be practically the same for the same strength as for structural steel.

A very important question often comes up when discussing mechanical davits: How will the weight compare with the old round-bar davits? The shipowner naturally does not like to put more weight than absolutely necessary so high up on his ship. If we now take as an example a 24-foot 30-person metallic lifeboat, the weight of this boat and equipment is 2,250 pounds; 30 persons at 165 pounds is 4,950 pounds; tackle and blocks 125 pounds, giving a total of 7,325 pounds. The smallest overhang radius that could be considered for round-bar davits to take care of this boat is 5 feet 6 inches. If these values are used in formula (2) the diameter of the davits must be 6½ inches. If, now, the davits are 9 feet above the boat deck and reach down to the deck below, the weight will be for the davits and brackets about 5,300 pounds. If the turning gear is added, the total weight will be at least 6,500 pounds. For the same boat a set of Welin quadrant davits, size D, 5 feet 6 inches would be used, weight 1,750 pounds. The round-bar davits in this case weigh 4,750 pounds, or 3.7 times more than the Welin quadrant davits. In every case the Welin quadrant davits will be much lighter than round-bar davits when figured to comply with the new law. At the same time they will be much more substantial than any other class of davits, and by their very looks will inspire confidence among the passengers, which is of great importance in time of disaster.

Another important question to answer is: Is it necessary to reinforce so heavily the deck as to make the use of Welin quadrant davits prohibitive? With a fully loaded 24-foot, 30-person boat hanging in the swung-out arms of size D, 5-foot 6-inch davits, the deck structure will be subjected to the following stresses for 15 degrees list of the ship. The pressure at the outboard end of the davit frame is 10,300 pounds and can easily be taken care of by a 2-inch pipe stanchion, unless, as is generally the case, the deck is amply strong enough, when no additional support is necessary. The pull on the deck at the inboard end of the frame is 5,750 pounds and can be taken care of by a ¾-inch rod going through the deck. The pull can also be taken care of by plate or angle iron under the deck, secured to two adjoining deck beams. The extra reinforcements will in most cases not exceed 200 to 300 pounds for a set of davits and is absolutely negligible. Therefore the comparatively small weight of davits and reinforcement will be an extra inducement for the shipowners to adopt the Welin quadrant davits.

The Schmidt davit is a gravity davit of the quadrant

class. There is no toothed rack or actuating screw on this davit. The arms are held in position at their lower end by two wire ropes going from each corner of the quadrant to opposite sides of the frame. The upper end of the arm is held by means of a rope leading to a drum on the frame over a sheave on top of a high stanchion on the inboard end of the frame. The two drums for one set of davits are worked simultaneously by means of a single shaft running between the davits. The quadrants roll in slots and are thus steadied sideways. The davits are placed in from the ends of the boat, thus eliminating the overhang of the arms. This, of course, brings the davit frames far inboard and the boats must be chocked exceedingly high above the deck. The davits are swung out by means of the force of gravity on the arms and the boats. This is not a safe proposition in the writer's opinion, as previously stated about gravity davits. It is therefore not deemed necessary to go into further details about this type of quadrant davits.

(*To be concluded.*)

Notes on the Conversion of Cargo Vessels into Bulk Oil Carriers—IV

BY F. K. RUPRECHT *

In the former case the vertical stiffeners will be bracketed to the tank top, and in the latter case they will be carried down and riveted to the floor plates and bracketed to them also (Fig. 9). The bulkhead will be continuous to the strip of plating on the centerline at the tank deck level where the stiffeners will be bracketed to the beams (Fig. 10). Above this the bulkhead extends to the upper deck, which forms the top of the expansion trunk. If the

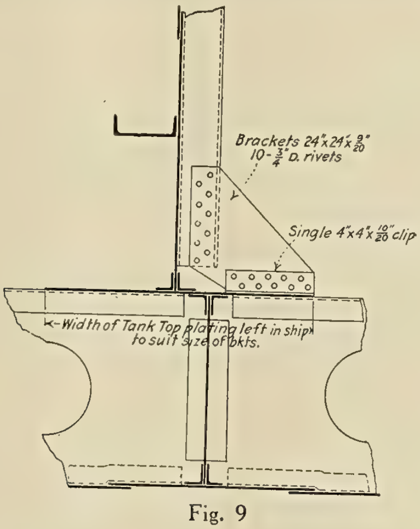


Fig. 9

tank deck is entirely removed this bulkhead and the stiffeners will be continuous to the upper deck. In this case extra stiffening is required, due to unsupported length of stiffeners.

The plating will be erected in horizontal strakes and the connection to the tank top will be by double angles, double zigzag riveted. The connection to the top and bottom of the shelf at the tank deck will be by double angles single riveted, and to the upper deck by angles of the same size. The butts and laps of the plating will be double riveted throughout. The horizontal stiffeners will be of the same size as those on the transverse bulkheads and will be bracketed to them as described in the following section.

* Associate Member Society of Naval Architects and Marine Engineers.

Aft in the way of the tunnel the centerline bulkhead will be built in three sections, one between the tank top and tunnel, or in some cases between the keel plate and tunnel. The second section will be from the top of the

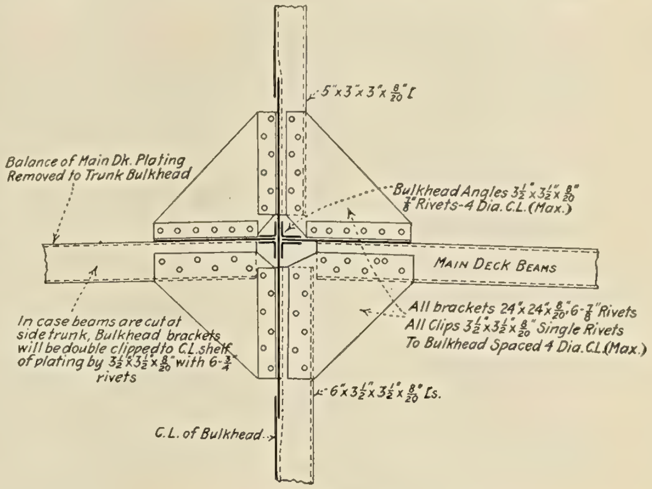


Fig. 10

tunnel to the shelf at the tank deck level, and the third section will be between this and the top of the expansion trunk. The connection to the tunnel will be by double angles of the same size as the angles to the tank top. The vertical stiffeners will be cut at the top of the tunnel and will be bracketed to the same as described under "Tunnel."

Vertical web stiffeners will be fitted in line with the web frames at the ship's side. These will be flanged plates of the width and weight required by rule, and will be connected to the bulkhead by single angles, single or double riveted, according to size. The webs will be clipped to the strip of tank top plating and special brackets will be fitted that will have a double-riveted connection to the web plate and to the floor plate (Fig. 11).

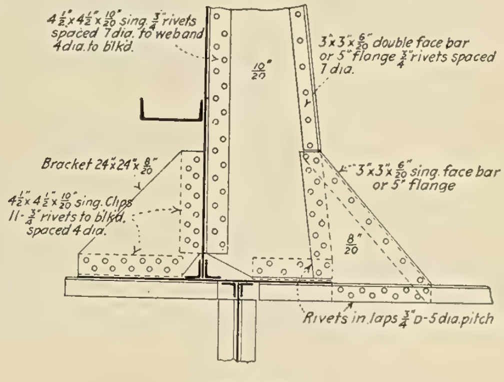


Fig. 11

Aft, in the way of the shaft tunnel, the web will be cut and bracketed to the tunnel stiffeners. Under the tunnel the regular type brackets as fitted in line with all other vertical stiffeners will be worked.

Supporting brackets to the webs from the bulkhead will be fitted at convenient heights, usually at the same level as the horizontal girders, and will be single clipped to the bulkhead and web plate. These will hold the web square to its work when the bulkhead is subjected to pressure. The webs will be double riveted at the tank deck level to the strong beams, and a bracket will be fitted to secure a good connection to the beam. In the expansion trunk the web will be straight flanged plates of the same width

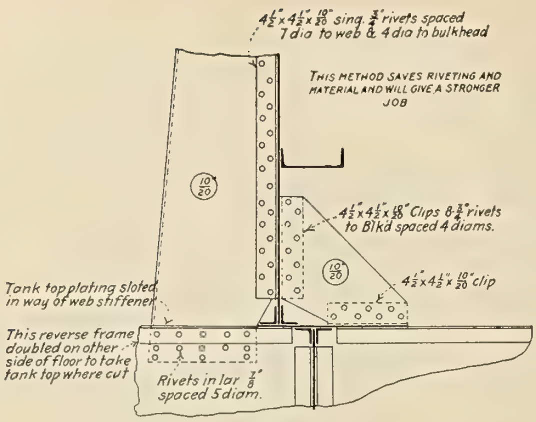


Fig. 12

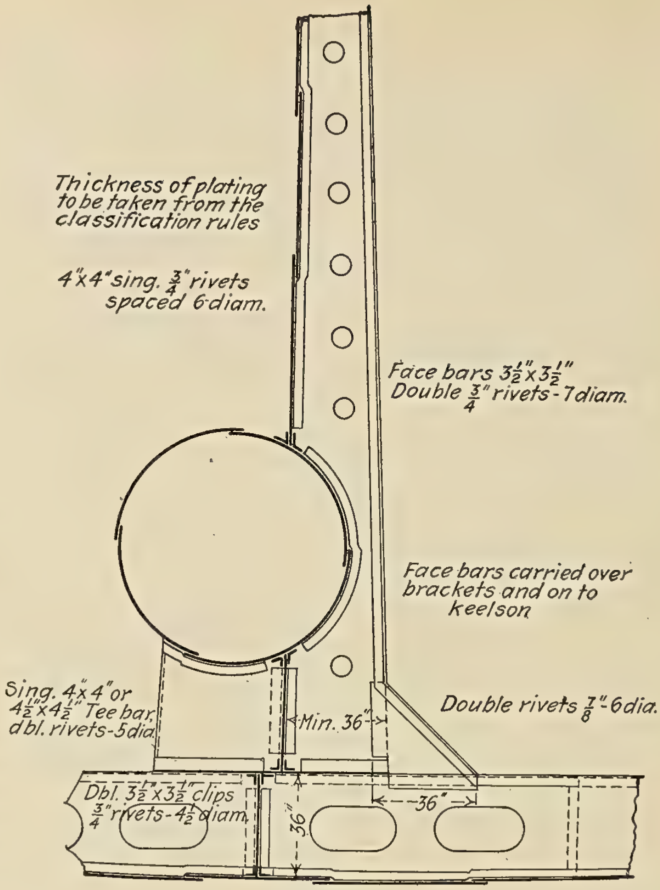


Fig. 13

as the top of the hold webs, and will be connected to the bulkhead in the same manner. They will be clipped to the strip of plating at the tank deck level and double riveted to the upper deck beam.

Transverse Bulkheads

The plating and stiffeners of all transverse bulkheads will be according to rule. Since the centerline bulkhead will be continuous the transverse ones will be constructed accordingly. The old frame floor plate and deck beams will be removed and a bottom horizontal strake will be fitted from the centerline bulkhead to the bilge. This strake will be deep enough to carry it well above the tank top level. As mentioned under "Tank Top," a strip of plating will be left on the horizontal stiffener side of the bulkhead. Double shell bars will be used single riveted or one large, double zigzag riveted may be substituted. The angles to the decks, expansion trunk bulkheads and centerline bulkhead will be of the same size as the shell bars. All corners of the angles will be welded and joggled over the continuous angles of the centerline bulkhead. An angle of the shell bar size will be carried along the bulkhead and riveted to the tank top plate on the under side. This angle will be the continuation of the bulkhead bar on the centerline keelson and will be carried to the margin plate and then calked. A corresponding angle will be carried along the top side of this tank-top plate and will be joggled over the centerline bulkhead angle and carried up the bulkhead (Fig. 8). On the vertical stiffener side these two angles will be carried to the edge of the tank-top centerline plate only and calked. If only single angles are fitted on the bulkheads, only the former remark applies. In newly constructed tank vessels single bulkhead bars are very often fitted, but in a conversion job it would be very difficult to secure oiltight work unless double bars are fitted.

The plating can be arranged in three ways: First, all strakes erected horizontally; second, all strakes arranged vertically; third, a combination of the first and second method. The latter is clearly the cheapest and the best arrangement seems to be as follows: A horizontal strake from the centerline to the bilge; this plate will be wide enough to take the angles at the tank top and to take the bilge radius. A vertical strake at the ship's side from the tank deck to the bottom strake. This means that only two plates have to be templated. The rest of the plates

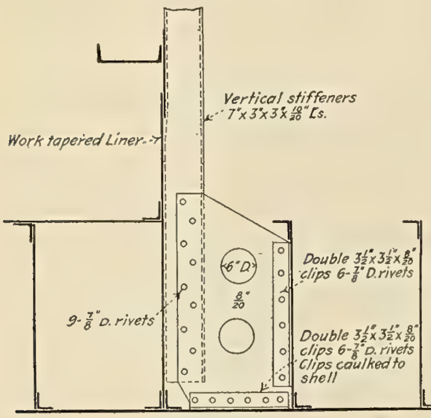


Fig. 14

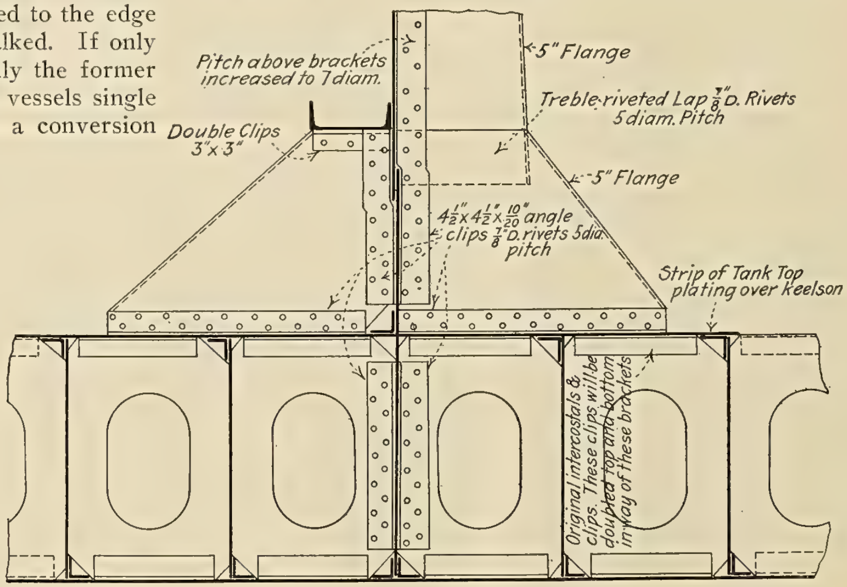


Fig. 15

will be arranged vertically to the tank deck level (Fig. 8). In the expansion trunk vertical strakes will be fitted between tank and upper deck. All butts and laps will be double chain riveted throughout and will be kept clear of all vertical and horizontal stiffeners to allow calking. The horizontal stiffened side will be the calking side.

The vertical stiffeners will be of bulb channel or Z-section, spaced about two feet apart, but they will be arranged so that a stiffener will be in line with each keelson. The stiffeners will be bracketed at the bottom to the outside plating and to the next floor plate by special brackets (Fig. 14).

In line with the side keelsons, vertical web stiffeners will be fitted. These will be flanged plates of the weight and width required by the registration societies rule. They will be connected to the bulkhead by a single angle, single or double riveted as required and clipped by single double riveted clips to the strip of tank-top plating over the keelson. A bracket will be fitted between the web and tank-top plating of a size sufficient to make the total length of connection two frame spaces. At the top the webs will be clipped to the tank deck and supporting brackets fitted at horizontal girder heights, as described under "Centerline Bulkhead" (Fig. 15).

The upper ends of the stiffeners will be bracketed to the strip of plating at the tank-top level. In the expansion trunk the verticals will be of the same section and will be bracketed at the tank deck level and to the upper deck beams.

If the wing spaces between the tank and the upper decks are to be used as summer tanks, transverse bulkheads will be built on the same frames as the main cargo bulkheads. The plating and stiffeners will be the same as the bulkheads in the expansion trunk. If these spaces are to be used for coal bunkers, only one bulkhead will be installed besides the cofferdam bulkheads (Fig. 3). The cofferdam bulkheads, however, will be built continuous from bottom plating to the upper deck, since the tank deck will be removed in them.

Horizontal stiffeners will be fitted to all bulkheads at the stringer levels. These may be built-up girders consisting of an angle riveted to the bulkhead, a wide plate and a heavy face angle. A cheaper way, and better from certain points of view, is to fit a large channel or I-bar instead of the more complicated built-up stiffener. The only disadvantage is that in some cases it is desirable to fit all the stiffeners on one side of the bulkhead, and while the girder plate can be cut out in way of the verticals, it would be impossible to fit channel stiffeners. The smaller amount of riveting needed with the channel or I-sections, cuts the expense for each bulkhead by a considerable amount. These sections can be made unlimited in strength by fitting face plates to the I-beams and reverse bars in the channels.

The horizontal stiffeners will be bracketed to the stringers by heavy flanged brackets three frame spaces in length by two frame spaces in width. They will be double riveted to both stringer plates and bulkhead stiffeners, and the shell clips to stringers will be doubled for three frame spaces each side of the bulkhead. On the vertical stiffener side the brackets will be double clipped to the bulkhead, single clipped and double riveted, and the vertical stiffeners will be worked intercostal and bracketed to the bracket plate.

At the centerline bulkhead brackets two frame spaces each way will be fitted at the horizontal stiffener levels. On one side the brackets will be double riveted to stiffeners and on the other will be double clipped, or single clipped and double riveted, to the bulkhead. The vertical stiffeners will be continuous and the brackets will be cut out to allow them to pass through; this means that the bulkhead clips will be fitted intercostal. All these clips will be calked oiltight.

(To be continued.)

Japanese Liner Fushimi Maru

Those who have followed the development of naval architecture and marine engineering in Japan cannot fail to appreciate the efforts put forth by the Nippon Yusen Kaisha (Japan Mail Steamship Company) and the Mitsu Bishi Dockyard & Engine Works. The former, aided largely by Japanese Government subsidies, is the largest shipowner in the Orient. Moreover, important technical researches are constantly being carried out by its staff of expert engineers. The latter is a private concern owned by Baron Iwasaki's family, whose immense wealth has enabled the yard to reach a high state of perfection in

Fig. 1.—S. S. *Fushimi Maru*

both its organization and equipment, so that it is now capable of building the largest ocean liners as well as super-dreadnoughts.

The latest product of these two concerns is the steamship *Fushimi Maru,* a twin screw full scantling steamer having the following dimensions:

Length overall	525 feet
Length between perpendiculars	505 feet
Breadth	63 feet 6 inches
Depth	37 feet 6 inches
Displacement	21,500 tons
Gross tonnage	11,000 tons
Deadweight capacity	13,000 tons
Measurement capacity	14,000 tons
Maximum speed	17 knots

As will be seen from the general arrangement plans, the *Fushimi Maru* has two complete decks extending from end to end of the ship. There is a continuous cellular double bottom extending from the collision bulkhead to the after peak bulkhead. The hull is divided into ten compartments by eight extra strong watertight bulkheads. The framing is especially strengthened according to N. Y. K. practice, which is to adopt heavier scantlings than usual requirements, especially in way of the boiler room and hatch openings. The 'tween deck framing is also stiffened.

The promenade deck and the upper deck amidships serve as the first class accommodation for 122 passengers, having rooms en suite and many spacious staterooms fitted with single berths. The first class dining saloon is situ-

ated on the bridge deck and provides 20 tables comfortably arranged under a large oval-shaped dome skylight. Near the saloon is a roomy pantry. The social hall and smoking room are on the promenade deck. The decorative scheme applied to the dining saloon, social hall and smoking room is one of the most attractive features, as this vessel is the only liner which has adopted the style of Japanese decoration that prevailed 400 years ago in the period known in Japan as "the age of Fushimi and Momoyama." A children's room, a bar room, a swimming tank, a dark room for amateur photographers, a laundry, a barber shop and all other rooms necessary for comfort on a long voyage are also provided.

The second class accommodation is situated in the poop for 60 passengers. The dining saloon is plainly yet neatly finished, and the smoking room is located on the poop deck, which affords ample promenade space. On the upper deck aft there are compartments for 12 intermediate and 190 steerage passengers. The captain's and officers' rooms are situated on the boat deck.

The vessel is equipped with wireless telegraph and fire extinguishers and a thorough equipment of electric lamps, electric fans, telephones and ventilators. Among other features are a disinfection apparatus, a refrigerating installation and a hospital and operating room, all complete; the fresh water is purified by a Buhring's filter.

There are sixteen boats, twelve of which are lifeboats placed under Welin patent boat davits. As to cargo handling for the six cargo holds aggregating 14,000 tons measurement capacity, there are fourteen powerful winches in addition to a special heavy derrick which allows taking a load of 40 tons. The cargo handling gear provided enables rapid loading and discharging of the ship's cargo.

The main machinery, which develops 12,000 indicated horsepower, consists of two sets of triple expansion engines designed and constructed by the Mitsu Bishi Engine Works. A novel feature of the engines is the use of cast steel supports. The condensing system is of the contraflow type, in which the vacuum can be adjusted according to the varying temperatures of the sea water, and in which all exhaust steam is utilized to its highest degree of efficiency. Unusually heavy coverings are placed on the steam piping and valve boxes in order to reduce the heat loss through radiation, and thence the consumption of fuel to a minimum. The steam is generated by seven Scotch boilers working at 200 pounds per square inch, fitted with Howden forced draft.

The vessel was launched on June 28, 1914, the keel having been laid on May 19, 1913. She was completed on November 23, 1914. The hull and machinery, including the auxiliaries, were all constructed by the Mitsu Bishi Company, except the ash ejectors and forced draft apparatus, which are of foreign patents.

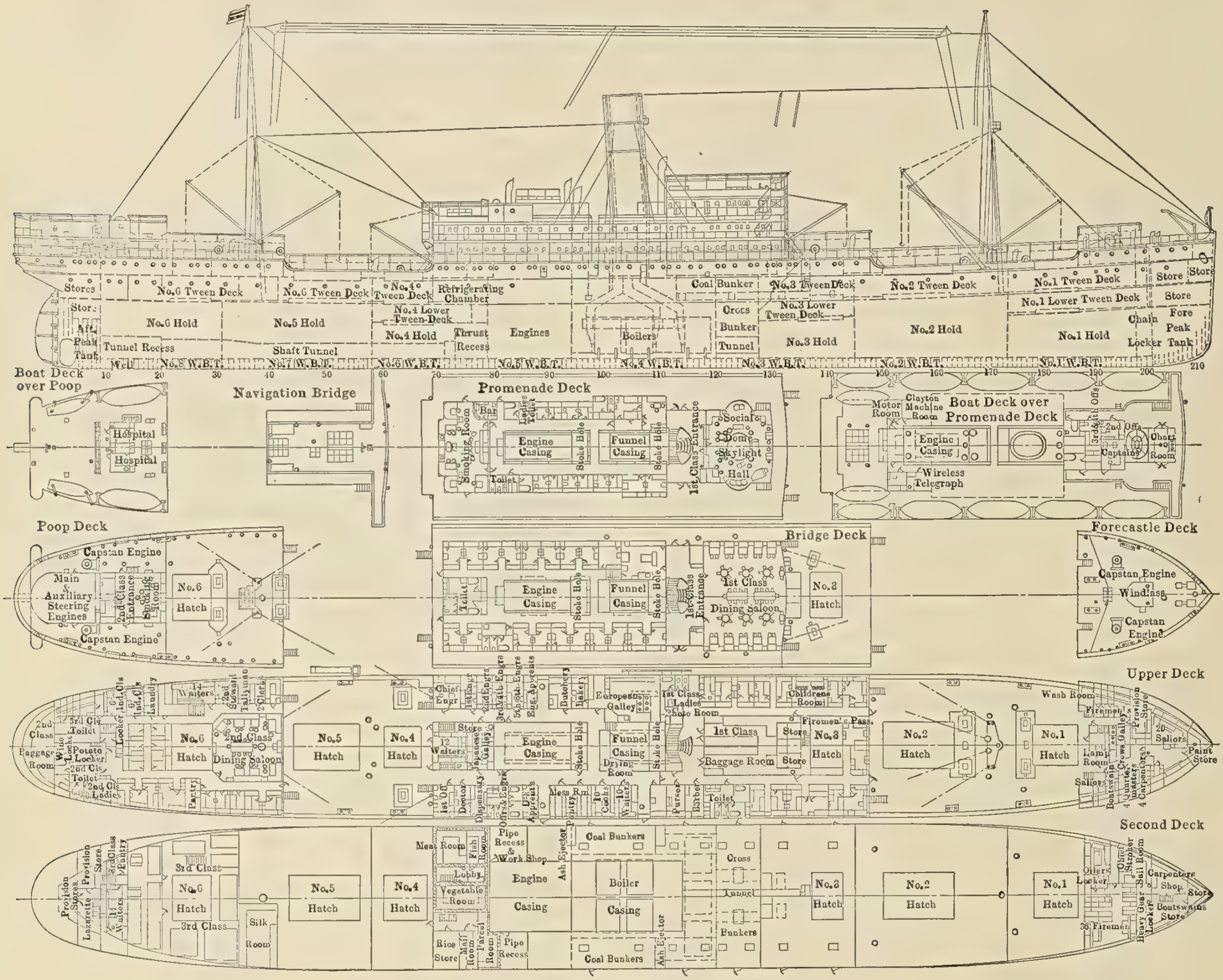
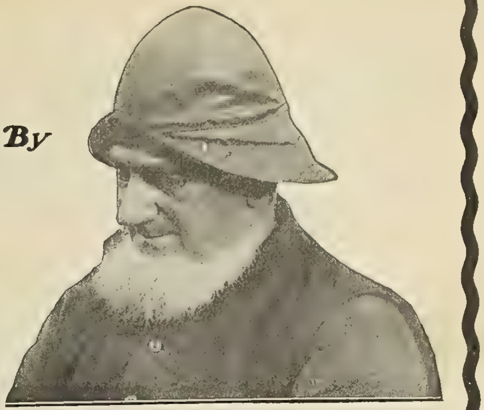


Fig. 2.—Profile and Deck Plans of S. S. *Fushimi Maru*

Economy Talks By "Old Scotch"



A Marine Engineer's "Paradise"

Well, boys! I have found her at last! She came right here to this port, and she's a beauty, too!

Oh, no! I'm not talking about girls, as I'm too old to be noticing petticoats. What I mean is that I've found the engineer's paradise. I've been preaching economy to you marine engineers for nearly a year, and now I've found the real thing in the economy line. The rewards of economy are comfort for the boys in the engine and firerooms, and this new creature which combines both comfort and economy is the *Northern Pacific,* now running between San Francisco and Portland.

Did you ever think in your wildest dreams that steamships would be racing express trains? Well, this ship and her sister are doing that same thing, and the best of it is that the steamers are beating the smoke wagons on shore. Think of scooting along 23½ knots, day in and day out, without anybody down below sweating over it, and you will not wonder that I call these clippers "paradises."

Think of a chief engineer having a cabin about 15 feet square all to himself, and a private bath on the side wherein he can wash up forty times a day, if necessary. Beats that galvanized iron bucket in the southwest corner of the fireroom that I used to have in my younger days, eh?

I don't believe any shipyard in the whole bloomin' country ever turned out any finer specimens of their art than these two packets. Although 524 feet long overall and lean in their lines, their 63 feet of beam gives plenty of room for everything. On these dimensions their gross tonnage is only 8,255, so you see that they must have pretty fine lines to hike along the way they do. As they can carry 856 passengers and 2,100 tons of freight, it would take a number of trains on the railroad to outcarry these boats. Every imaginable comfort for the passengers is provided, and it is just about as much trouble to travel between these two ports now as it would be to hire a room and sit around the St. Francis or the Waldorf hotels for a day or so.

Ah! but it's down in the engine and firerooms where the real comfort is found for the workingman. As you walk down the engine room ladder you might think you were going into an immense "rathskellar" (that's German for a liquid fuel station). The high-pressure turbine drives the central shaft and two low-pressure turbines drive the wing shafts. They look like three immense tins for holding the brown fluid. Talk about room to swing a cat by the tail! Well, there's room enough in those engine rooms to swing a camel by the tail; that is, providing his tail wouldn't break off while you were swinging him.

The first thing that strikes you is the simplicity of everything. I don't see how it would be possible to arrange marine machinery with less valves, pipes and other things than you find here. The wrought steel exhaust pipes look big enough to drive a Ford through them without touching the sides and tops.

The shaft alley is big enough to hold a Democratic convention in, and the strangest thing that strikes an old-timer like me is the size of the three main shafts. Just think of steel shafts only 12¼ inches in diameter to transmit over 7,500 horsepower each! They look like lead pencils compared with the shafts for reciprocating engines of that power. All the oiling is done by forced lubrication, and that extends to a new wrinkle for oiling the stern tubes. They force a special oil into the tubes under a pressure just sufficient to overcome the pressure of the water outside. This reduces the friction and saves the lignum-vitæ. I suppose the next thing they will be doing is to oil the skin of the ship so she'll slide through the water easier.

Firing on this ship is a "cinch," if there ever was one at sea. She has twelve watertube, oil-burning boilers of a new type, built by the Babcock & Wilcox Company. Two-inch tubes are used, so they can be cleaned quite readily with a turbine cleaner. The boilers are operated on the closed fireroom system of forced draft with mechanical atomization oil burners. The air is admitted both at the bottoms of the boilers and in the fronts, so that correct combustion is a matter of easy regulation. Although there are twelve boilers in the ship, they can maintain their scheduled speed on ten, leaving two dead, so that they can be cleaned when necessary during the voyage.

When I first began these papers I dwelt at length on the economy in reducing smoke and keeping the CO_2 regulated. I was, therefore, glad to see at least one vessel where they make arrangements to have the men in charge of the fireroom pay attention to these important items. By a very ingenious device the fireman can tell at a glance the density of the smoke passing up the stacks, and also get a fair approximation of the percentage of CO_2 in the waste gases.

As these ships run in competition with the railroad, they have to keep going on a regular schedule, and a lively one at that. They are only in port at each end of the run for about nineteen hours at a time. I am informed that they are averaging 8,600 knots a month, which is some running, believe me. I doubt if any steamers in the world are making any better mileage than that.

I wish I was a young man starting in to go to sea again. I would surely apply for a job on one of these flyers, where a man could take an interest in running these paradises of the Pacific.

Yours for economy,

Old Scotch

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

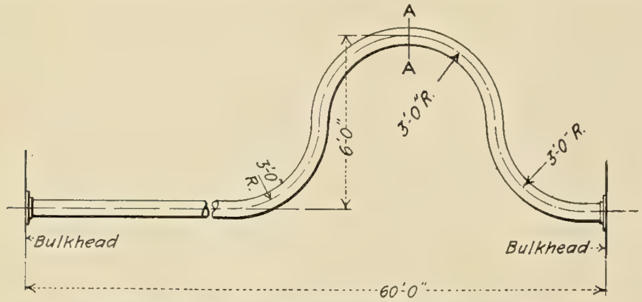
This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Stresses in Expansion Bends of Steam Lines

Q.—Will you kindly inform me through your Query Department how to figure the stresses in expansion bends of steam lines? To take a specific case, I inclose a sketch of a 6-inch steam pipe, ¼ inch thick, subject to a steam pressure of 180 pounds per suare inch. R. P. S.

A.—An exact solution is involved and difficult and probably not worth the time required when a result, sufficiently accurate for general engineering work, can be obtained by the following approximate method.

There should be borne in mind, however, the assumptions made in the solution. The pipe has a straight length of about 60 feet — 12 feet = 48 feet, which expands along its



Seamless Drawn Steel Pipe, 6 Inches Inside Diameter, ¼ Inch thick, Steam Pressure 180 Pounds per Square Inch

axis when heated by the steam. If the room temperature is assumed to be 70 degrees F., then the increase in the temperature of the pipe, when carrying steam at 180 pounds gage and 380 degrees temperature, is $380 - 70 = 310$ degrees. The coefficient of expansion for a steel pipe of this character is customarily taken as .0000065 per degree difference of temperature, so that the straight pipe will increase in length $48 \times 12 \times .0000065 \times 310 = 1.61$ inches. This increase in length must be taken up by the expansion bend and corresponds to the deflection which that bend would be subjected to.

The character of the bend shown is such that each quadrant would take up one-fourth of the total movement. Therefore, considering the semi-circular section at the middle, this could be figured in a manner similar to the customary calculation for a hook. This semi-circular bend has a deformation of $\frac{1.16}{2} = .58$ inch. From tests which were carried out upon actual pipes of this sort to determine the loads required to produce certain deflections ("Steam Boilers," Peabody and Miller, 1908, p. 293), it is possible to predict the load in consonance with this deflection. This is (pipe No. 2) 2,290 pounds at 5 feet from the apex of the bend or 3,815 pounds at 3 feet from the top. Consider a section at the top of the bend (*A-A*), the bending moment about this section will be $3{,}815 \times 3 = 11{,}445$ foot-pounds and the stress due to bending will be

$$F = \frac{M\,y}{I} = \frac{11{,}445 \times 12 \times 3.25}{24.1} = 18{,}500 \text{ lbs. per sq. in.}$$

The direct stress is

$$\frac{\text{load}}{\text{Section A}} = \frac{3{,}815}{5} = 765 \text{ lbs. per sq. in.}$$

The total stress then is $18{,}500 + 765 = 19{,}270$ (approximate).

It should be noted that if the character of the bend or its juncture with the main steam line differ appreciably from the sketch, the details of the solution differ accordingly.

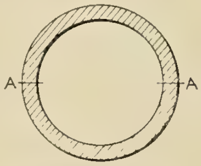
Strength of Main Steam Pipe

Q.—How do you calculate the strength of a main steam pipe? L. D.

A.—The calculation is made considering the pipe as a thin hollow cylinder. If we take a section of the pipe one inch long and let

P = pressure in pounds per square inch.
D = diameter in inches.
t = thickness of the pipe wall in inches.
f = fiber stress in pounds per square inch,

then $P \times D$ is the load tending to separate one-half of this ring from the other and split the pipe along a longitudinal element. This is resisted by the two strips of pipe at A and A, which together have an area $= 2\,t$, therefore



Section of Pipe

$$f = \frac{P \times D}{2\,t}.$$

Pressure Oil Burners

Q.—Will you kindly explain to me a few of the most used pressure oil burners for naval purposes. I am especially interested in the Peabody burner and would be obliged if you can give some sectional drawing of it. NAVAL ENGINEER OFFICER.

A.—The commonest oil burners of the pressure type used in this country are the Thornycroft, Normand, Schutte-Koerting, Peabody and Fore River. Abroad the Kermode, Wallsend and Mejani are also common. All produce atomization mechanically by having the oil discharged from the burner under high pressure (about 200 pounds per square inch) and at a high temperature. The draft is customarily on a closed stokehold system and the amount of air used is regulated either by varying the pressure in the stokehold or by varying the size of the air admission holes. If natural draft be used, this latter is the only means available for regulating the air supply. In order to properly control combustion, powerful fans are

* Associate Professor of Naval Architecture, Massachusetts Institute of Technology, Boston, Mass.

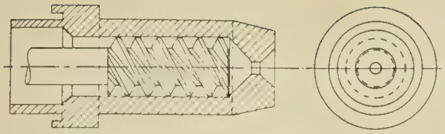


Fig. 1.—Schütte-Koerting

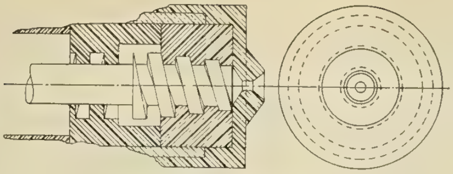


Fig. 2.—Thornycroft

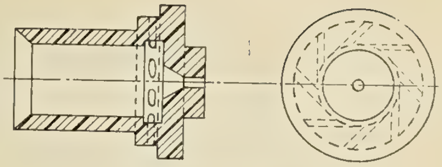


Fig. 3.—Normand

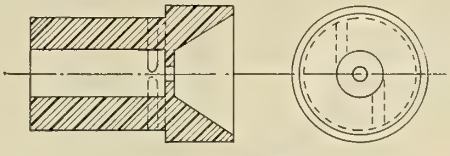


Fig. 4.—Fore River

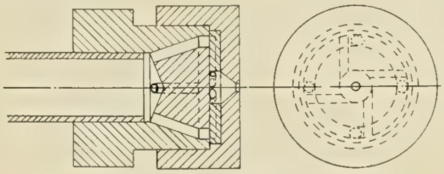


Fig. 5.—Peabody

Sketches Showing Characteristics of Atomizing Ends of the Principal Makes of Oil Burners

used which should be built to give a range of air pressure in the stokehold of from 3 to 4 inches. The oil fed to the burners is capable of regulations both by variation of the pressure and adjustment of individual burners, but the former is preferred, as it results in a simpler burner. The

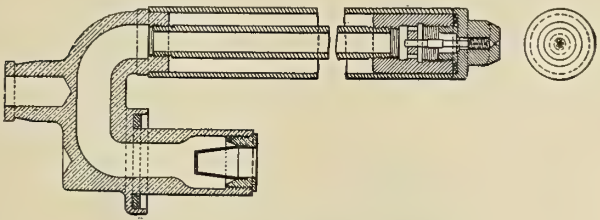


Fig. 6.—Schütte Koerting Burner

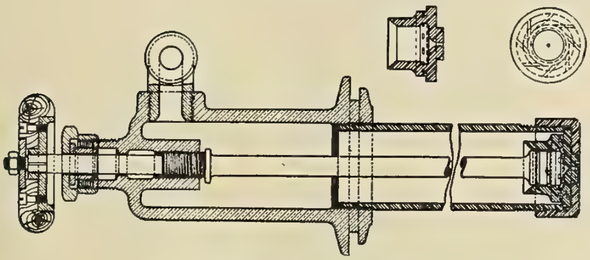


Fig. 7.—Normand Burner

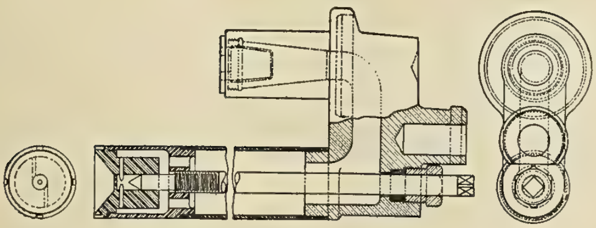


FIG. 36.

Fig. 8.—Fore River Burner

shutting down of a portion of the burners, if the air pressure regulation is insufficient, is easier than to attempt individual regulation. At present all burners of the pressure type force the oil through the burner through internal channels such that it has a rapid whirling motion close to the point of exit and is discharged in a fine conical spray. There are two methods of giving the oil this whirling motion previous to exit; first by using a passage of helical form, and, second, by delivering to a central chamber, close to the exit, by means of ducts which enter tangentially.

Examples of this first sort are shown in the sketches (Figs. 1 and 2) of burner tips of the Schutte-Koerting and Thornycroft burners, and of the second type in the

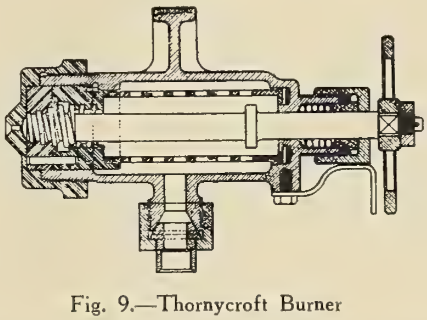


Fig. 9.—Thornycroft Burner

sketches of the Normand, Fore River and Peabody burners (Figs. 3, 4 and 5). These sketches give the fundamental differences of the various types. Figs. 6, 7, 8 and 9 show small views of the assembled burners.*

Slip of Screw Propeller

Q.—In the ship .... the revolutions per minute average about 78. She has a wheel which is 14½ feet diameter and 15 feet pitch, and makes a speed of about 10 knots. What is the slip of the screw? C.

A.—The apparent slip is

$$\frac{\text{Pitch} \times \text{R. P. M.} - \text{speed in ft. per min.}}{\text{pitch} \times \text{R. P. M.}} = \frac{15 \times 78 - \dfrac{6080 \times 10}{60}}{15 \times 78}$$

$= .134$ or about 13½ percent.

Spacing of Spring Bearings

Q.—What is the rule for the proper spacing of the spring bearings along the tunnel shafting? M. T.

A.—Assuming an allowable deflection between bearings of a constant amount per foot of length, the distance between bearings is, for solid shafts, a function of the 2/3 power of the diameter of the shaft. The following rule gives results in accordance with good practice:

$$L = KD^{2/3}$$

where L = length between centers of bearings in feet. D = external diameter of shaft in inches. K = 2.5 to 3.5.

* From "Developments in Oil Burning," by E. H. Peabody in the Transactions of the Society of Naval Architects and Marine Engineers for 1912.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Some Defects and Remedies of Marine Diesel Motors*

Marine engineers the world over are a very conservative lot, and consequently the introduction of Diesel engines for the propulsion of vessels was looked upon with more or less disfavor. Although each new account of trouble with the motors seemed to justify this conservatism, nevertheless it was only natural to expect considerable trouble with the early ships. The change from the old reliable steam to oil motors was very great and somewhat in the nature of an experiment. Great strides have been made, however, during the last year or two. Many of the weak points of the early motors have been eliminated and great improvements have been made both in the design and construction of the various motors built, so that they now compare favorably with the steam engine. At the same time, the men who run these engines must be enthusiasts, not afraid of either dirt or work, both of which they will get in good measure.

It is the writer's intention to chronicle a few of the defects and breakdowns of one of the first large motor vessels, and how these have been successfully overcome, so that now we can cross the Atlantic in stormy wintry weather without a stop for any adjustment. The vessel has a deadweight capacity of 6,500 tons and is propelled by two single-acting four-cycle engines of six cylinders each, of the open type. The vessel has run approximately 120,000 miles since she went into commission nearly three years ago.

The motors are built with the back columns of cast iron, which simply take up the guide strain. These are not bolted to the cylinders, but are left slightly free of same. Steel columns which take up the whole stress of working are fitted as closely to the centerline of the engine as possible. The cylinders are secured to these. Steel diagonal tie rods are also fitted from the foundation plate to the bottoms of the cylinders, which stop any tendency of side play. This arrangement makes a light and very open engine.

The cylinders and head are cast in one piece and dropped into a frame with a fitting strip top and bottom, the rest being left clear for water circulation. On the bottom of the cylinder is bolted an extension piece bored true with it by means of which the piston can be lowered for cleaning or examination, and if necessary new rings can be fitted without disturbing any pipes, levers or high-pressure joints. This results in a great saving of time—in fact, the whole operation of examining, etc., takes less than an hour. We became quite adept at this work during the first few months we were on this vessel, as the pistons were connected to the rods by four 1¼-inch tap bolts which were continually breaking. Nickel steel was tried, but while this did not break, the material stretched. The consequent hammering of the piston on the rod did not conduce to a quiet working engine. On one occasion, when we stopped to examine, we found two of the bolts broken, the remaining two beieng nearly ½ inch slack. Other methods were tried, but with no success. Then new pistons were supplied with a flange cast on the under side and through bolts were fitted to the piston rod, which cured the trouble.

In the original design of water cooling for the pistons, telescopic pipes of steel were fastened to the bottoms of the pistons working into a larger sized outer pipe through stuffing boxes and glands. These steel pipes corroded very quickly with the action of the water, as it was then impossible to keep the glands tight. They were replaced by pipes of brass which worked fairly well, but on account of the slack piston trouble, they broke off at the neck frequently. Finally they were thrown out and the present system installed, which consists of a small jet of water forced up into the piston, the telescopic pipes having no rubbing parts, simply working up and down with the piston to prevent the water splashing.

It was also found after running a short time that the cylinder water cooling was not as it should be. The back part of the head was very hot, while the front was quite cold. Of course, no metal could stand that strain long and several of the heads were cracked. The trouble was that the head valves were crowded together too closely and the water being unable to get from one side to the other would lay stagnant. This was remedied by fixing a pipe to the back part of the head and discharging separately. With the new design of cylinder, which the builders of this type of engine are now using, the valves are placed well apart, giving a free passage for the water.

All of the water cooling is done by means of salt water. After a short trial running with sea water, the fresh water arrangement originally installed was cut out and nothing detrimental has been found up to the present time. No incrustation or salting up has taken place. This is a very important matter, as working with fresh water means that a large quantity of fresh water must be carried to make up for the inevitable loss. By using sea water a considerable amount of piping, etc., is eliminated.

With the motor proper, the exhaust valves are a rather weak part. These are of the ordinary mushroom type and if allowed to become overheated are apt to break and drop on top of the piston. The inlet air valve opens at the moment the piston is at the top of its stroke, so the inevitable happens and the inlet valve spindle is bent. Of course a full set of valves and chests are carried as spares, so it is quite a simple matter to replace them. At the same time it is not advisable to run too long without overhauling the exhaust valves. We find it best to take them adrift after each voyage in order to clean and grind them.

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* This letter is from the chief engineer of the motor tank ship *Emanuel Nobel*, owned by the Société Anonyme d'Arment d'Industrie et de Commerce of Antwerp, and under charter to the Sun Oil Company, of Marcus Hook, Pa., for transporting oil from Philadelphia, Pa., to Rouen, France. The vessel is 390 feet 6 inches long, 51 feet beam, 29 feet molded depth, with a displacement of 9,000 tons and a deadweight carrying capacity of 6,500 tons, including 350 tons fuel, 30 tons stores, 100 tons water and 40 tons drinking water. Propulsion is by twin screws actuated by two 6-cylinder Werkspoor, direct-reversible, single-acting, four-cycle Diesel engines of 22-inch bore and 39⅜-inch stroke, each developing 1,325 indicated horsepower at 105 revolutions per minute. The vessel was built in 1913 by the Netherlands Shipbuilding Company of Amsterdam, and the contributor of this letter has been in continuous service as chief engineer of the vessel since she went into commission.—The Editor.

The only time the fuel valves give trouble is when dirt gets in with the oil, which gradually chokes the small holes in the diaphragm. This is soon noticed by the exhaust becoming smoky and the injection air pressure tending to rise. It is best when this happens to stop and overhaul, as if the trouble goes on too long it is apt to burn the end of the fuel chest.

One of the most interesting breakdowns I think we have had was when the intermediate- and high-pressure compressor cylinders were smashed up. These are of the tandem type, with the low-pressure on top and the intermediate- and high-pressure below, the latter pistons and rods being all in one piece and driven by balance levers from the main motor. The high-pressure piston had seized in the chamber, causing a complete smash. Both cylinders and pistons were broken and driven across the platform, bending and breaking the steel air and water pipe connections. The heavy steel crosshead was also slightly bent and the driving links were elongated nearly ¼ inch.

This happened at 3 A. M. and the oiler, who was standing close by, promptly bolted on deck out of harm's way. We commenced at once to fit the spare cylinders and put everything in order. The steel pipes caused the greatest trouble, but after forty hours' continuous work we had the satisfaction of getting under way and working both motors to our destination.

Another bad smash was the breaking of the large wheel of the half-time cam shaft gear. This is worked by a small cog wheel secured on the main crankshaft geared into a wheel of double its diameter fitted on a small crankshaft, being connected with suitable rods to another small crankshaft operating the cams, which revolves at half the speed of main shaft. A piece of metal had dropped into the teeth, breaking the large wheel, bending the small crankshaft and breaking its bearing bracket.

This was a most serious breakdown, since, although we had a spare wheel on board, the necessity of straightening the crankshaft was a big order. Moreover, every part had to come in exact, otherwise the timing of the valves would be wrong. In fact, it looked so formidable that we gave it up as a bad job. Eventually, however, we made a start and as we proceeded we found that it was not quite so difficult as we had imagined, and after thirty-five hours' hard work in a heavy rolling ship, we got the motor started up again. All worked well—in fact, the job was done so well that it was not found advisable to touch anything on arrival in port, and it continues to work as well as it did before the accident.

It should be pointed out that neither of these breakdowns had anything to do with either the design or construction of the motors. The first was the fault of the lubrication and the second was due to the carelessness of the engineer on watch. Otherwise, the only trouble we ever have with the whole of the compressing plant is occasionally the breaking of a suction valve in the intermediate-pressure cylinder, which is renewed in a few minutes. As the whole is driven by the motors, it is a very compact and simple plant.

For starting the motors, compressed air, of course, is used, at a pressure of 270 pounds per square inch, the fuel being injected into the cylinders at 900 pounds per square inch, so that all joints and piping must be strong and well made. The lubrication is on the gravity system, the oil being used over again; the crankpits are oiltight, so that good filtration is necessary. Fifteen gallons is usual for the engines per day, and 20 gallons per day for pistons and auxiliaries. The latter are all steam-driven, a boiler being fitted in the engine room having two furnaces, the exhaust gases from the main Diesel engines continually passing through one, thereby utilizing the waste heat, while in the other is an oil burner. During the day we can dispense with the burner altogether, enough steam being generated by the waste gases.

The fuel consumption for all purposes per day is 9½ tons of gas oil, for the main motors 8¼ tons and for the boiler ¾ ton. This gives 0.3 pound per indicated horsepower per hour under average running conditions. The overall consumption, including auxiliaries, works out at a little less than .4 pound per indicated horsepower per hour.

When the vessel came out she was fitted with three-bladed propellers of 10-foot pitch, but there was considerable vibration in the ship. These propellers were later replaced by four-bladed wheels with a foot more pitch, the revolutions being then 105 per minute and with no vibration whatever.

In the writer's opinion, Diesel motors for marine work will be greatly simplified in the future. There is still a tendency to make them too complicated. There are too many parts to go wrong. There is no doubt, however, that as experience is gained many things will be altered. There is still a great field for research in this respect.

T. I. GRAINGER,
Chief Engineer, M. S. *Emanuel Nobel.*
Rouen, France.

The Need of an Enrolled Naval Reserve

The April issue of INTERNATIONAL MARINE ENGINEERING contains a timely editorial which discusses a method of obtaining a naval reserve and at the same time of assisting the merchant marine under the United States flag engaged in the foreign trade. This is a question of vital importance to the navy, but it is not at all generally appreciated by the American people.

The last Congress enacted laws which will give (at least they are expected to give) an adequate trained reserve for the active fleets as well as for those in reserve. This reserve will be composed entirely of men who have served in the navy and will, therefore, measure up to a high standard of efficiency and ability. The fact that members receive pay for their services should tend to make the majority of honorably discharged men, who are returning to civil life, desire to belong to the reserve. It must be understood that the formation of this reserve will be a rather slow proposition; nevertheless it should be successful in the end.

Every naval officer fully appreciates the urgent necessity for such a reserve. It is needed to bring existing complements up to their war strength, to fill up skeleton crews of vessels in reserve, and to furnish the men necessary to fill in in case of casualties. Contrary to usual opinion, even the ships in the active fleet which apparently have full complements would really need many more men to place them on an actual war basis. They could get along with the number they now have, but they would be much better off with from one hundred to two hundred additional men on each battleship. These additional men must come from the reserve.

But there is a reserve needed for another class of ships that cannot be classed as strictly naval vessels. By this I mean the men needed to man the immense number of vessels required to supply the wants of a modern fleet when operating at a distance from its established bases. The number of such vessels required to supply a first class modern battle fleet (including battleships, battle-cruisers, destroyers, mine layers, submarines, aviation ships, etc.) is simply astonishing to the untrained mind; in fact, it is astonishing even to the trained mind which has not care-

fully investigated this matter. The number is so large that it is not well expressed by dozens or scores; it runs into the hundreds.

It is pertinent to inquire where we are intending to get the men necessary to man and operate this immense number of ships (even after we get the ships themselves). That they must be manned is not open to question; it is only a question of how efficiently they can be manned. It is difficult to believe that the ordinary merchant crew (which usually includes a large number of foreigners) would prove very efficient in this service in time of war. It would therefore appear extremely necessary to provide some means by which each vessel assigned to this auxiliary service could be immediately fitted out with an intelligent crew of American citizens. I do not mean to insinuate that it is not possible to have an intelligent crew which includes many foreigners, but I think that everyone will acknowledge that a foreigner can hardly be expected to take the same interest in the welfare of this nation that should be normally expected of an American citizen. It should therefore be the policy of the nation to use American citizens wherever it is possible to do so, when engaged in war.

The greatest difficulty in carrying out the above policy is the scarcity of Americans who follow the high seas as an occupation. The coastwise fleet, being all under the American flag, should furnish a good many men for such an auxiliary naval service, but surely it would not furnish more than one-third of those required. In addition to those in the coastwise shipping, there is a large body of men engaged on the Great Lakes. Many of these men have never seen the high seas, but, since a ship is a ship whether in fresh or in salt water, their lake experience, coupled with a desire to make good, ought to make them very adaptable for the auxiliary service. The writer believes that we shall be obliged to turn to the lake shipping for a large number of men in case of war. That these men will make good, after they have had a little experience, is not to be doubted.

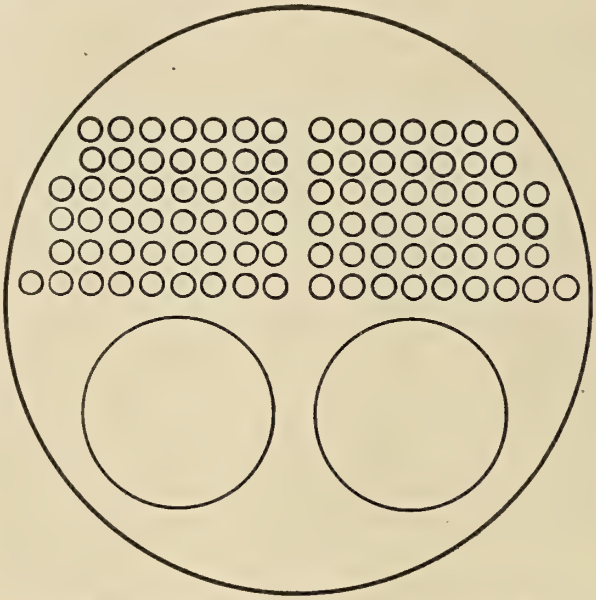
But even though we have fields from which some men can be obtained in case of need, this does not give us a system by which we know just how many men can be obtained, just what each man can do well, and where to send each man when the time comes. Some system of enrollment which will give all of this information (as well as much other) is badly needed. The needs of the fleet will not wait while we gather the information we should have carefully compiled in times of peace.

A Naval Officer.

Poor Circulation in Boilers

One of the common ailments found in boilers is poor circulation. This is due to several causes. Some boilers are improperly designed, and no change that will remedy this trouble can be made after they are built; but one of the causes of poor circulation that the writer has occasionally met with, and which is curable, is the placing of too many tubes in a boiler, due to the desire of the designer to get as much heating surface in the boiler as possible without exceeding a specified diameter. A boiler is sometimes found with the tubes arranged as in the accompanying sketch. It will be noticed that the top and bottom rows of tubes in this design extend close to the shell of the boiler, and that there is no break in the rows.

In the case illustrated, the steam formed on the furnace sheets cannot rise to the top freely, being checked by the flow of water downward, there not being space for one to pass the other. This defect could be remedied by removing one tube from each side of the horizontal rows and one vertical row in the center. This may be objected to on the grounds of insufficient heating surface and also of restriction of the passage of the burnt gases, but all marine engineers know that it is common for a boiler with 150 or 200 tubes to have 15 or 20 of them plugged at one time without any appreciable difference in the steaming qualities of the boiler. If this is so in a boiler that has good circulation, it follows that if by removing the same number of tubes in a boiler that has poor circulation the circulation is improved, the increased quantity of steam generated by the better circulation will more than compensate for the decreased heating surface and restricted draft. The boiler that has the more nearly perfect circulation, other things being equal, will generate the most steam.



Sketch Showing Arrangement of Tubes in Scotch Boiler

This admits of no argument, and anything that can be done to make the circulation better makes for better steaming qualities and economy of fuel.

The tubes in many cases are too close to the furnace crowns and the space does not permit perfect circulation. In some cases the tubes are too close together. Many boilers that have tubes 3 inches in diameter would do better work with tubes 2½ inches in diameter, spaced the same distance between centers, the better circulation more than compensating for the decreased heating surface, but these are defects that cannot be remedied once the boiler is built.

Poor circulation causes other defects besides decreased steaming qualities and waste of fuel. It is always found that boilers which have poor circulation are subject to corrosion and pitting internally, particularly under the back connections and bottoms of furnaces and flues. The water which lays stagnant in the bottom of a boiler soon becomes charged with all the elements of a galvanic battery and attacks the sheets with which it comes in contact. There are a number of good boiler circulators on the market, which circulate the water in the bottom of a boiler more or less effectively and are well worth the amount it costs to install them.

Another evil of poor circulation is the tendency of boilers so afflicted to foam. When there is insufficient space for the steam to rise to the surface of the water freely it accumulates near the heating surface, and when there is a sudden opening of the throttle, or lifting of the safety valve, the accumulated steam rises to the sur-

face of the water rapidly and carries the water with it over into the steam pipe.

It is hardly necessary to mention the difficulty of keeping a boiler which is afflicted with poor circulation tight in the bottom seams. Every marine engineer is fully aware of this. Broken staybolts are another result of poor circulation. In raising steam on a Scotch boiler it frequently happens that the pressure rises to 100 pounds before the water in the bottom starts to circulate, and the sudden expansion of the bottom of the boiler when the temperature equalizes throws a severe strain on the staybolts that often causes them to break.

Practice and theory work splendidly together, much better than when used separately, and it would seem that all designers of boilers should study the practical operation of boilers as well as their theoretical efficiency. J. S.

Repairs to a Babcock and Wilcox Boiler

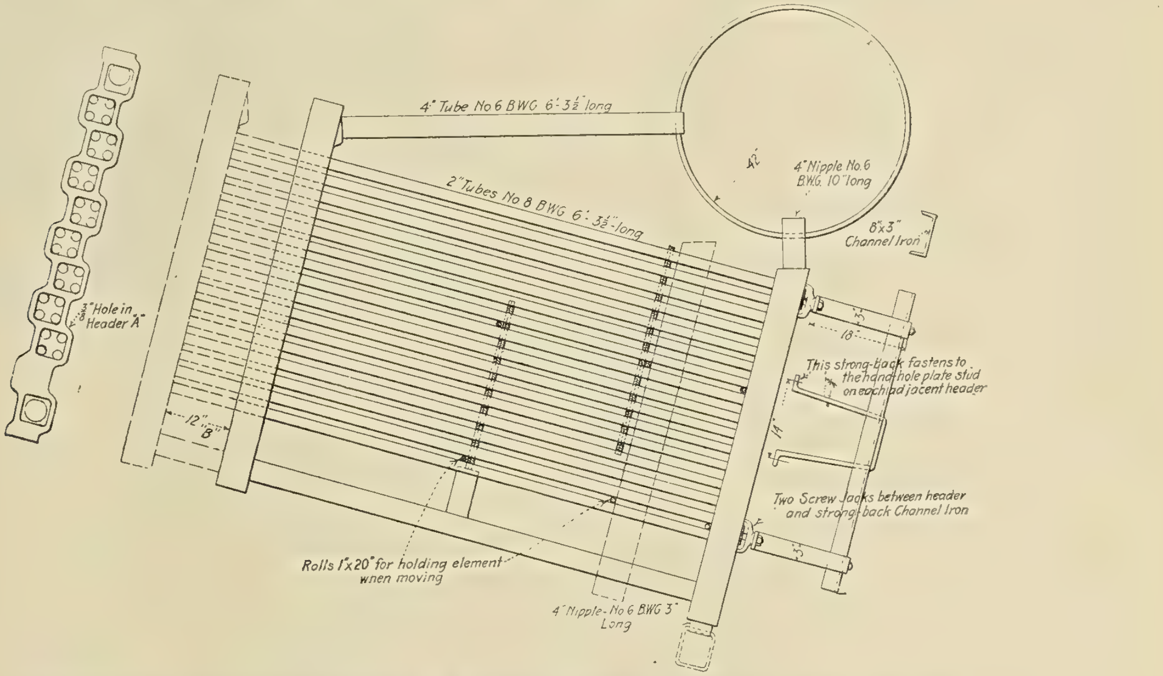
At about twelve hours forty-five minutes post meridian, January 26, 1915, while the U. S. S. *Nebraska* was steaming in formation at drill off the southern coast of Cuba, a violent noise caused by the escape of steam was heard in boiler No. 3. This gave no alternative save hauling fires with rapidity and trepidation. When this was completed, and safety permitted an examination to be made, it was found that water and steam were escaping between the fourth and fifth headers at the back of the boiler counting from the left.

When the vessel reached port as much of the asbestos as could be gotten at was dug from between the headers, showing the damage. The boiler was slowly filled until the defective header could be identified, which was found to be the fourth header. There were no spare parts of this kind available at the time, and on account of the strenuous duty necessitating the service of all power, it was decided to attempt repairs to the old header, which was then cut out, destroying thirty-six 2-inch seamless drawn tubes 8 feet 2 inches long, and two 4-inch seamless drawn tubes, one 6 feet 3½ inches long and the other 8 feet 2 inches long, a total cost of $51.50 (10/14/7).

The defect in the header was a hole about ⅜ inch in diameter which had blown in the curvature of the header, shown in the sketch and noted by the letter "A." The header was manufactured in 1900, and in making the curvature the metal had been drawn thin. As there is no means of cleaning the rust from between the headers, corrosion at these points is permitted to go on without abatement, thus rendering ruptures in old boilers to be expected, this being our third similar experience in two years.

After the header was cut out and sent to the repair ship the hole in the header was filled with metal by the oxy-acetylene process, so that metal projected into the header through the hole for a distance of 2 inches, the metal being built up on the outside only. The cost of rigging the header for a test being prohibitive, it was concluded to install the header without a test.

When the installation was completed, at a cost for material of $103 (21/9/2) and a labor cost of $44.52 (9/5/5), a test was put on the boiler and it was found to leak at a pressure of 150 pounds, the working pressure being 265 pounds. This looked like doing all of the work over again, which would have made the job cost, for material $154.50 (£31.7), labor $89.04 (£18.3), total $243.54 (£50). A realization of this fact made us adopt the following process, so as to save the tubes at least:



Sketch Showing Arrangement and Method of Removing Element of Babcock & Wilcox Boiler for Purposes of Welding Hole in Rear Header

The upper 4-inch tube connecting the back header with the drum was heated with a blow torch where it is expanded into the header and the end crimped to allow the tube to be drawn from the header and left in place in the drum. The front and back doors were removed and the casing in wake of the header lifted clear. Two strong-backs were then made of ¾-inch by 3-inch steel, shaped so as to bridge the front header of the element having the defective back header. The nuts were removed from four hand hole plates in the adjacent headers, one from the top and one from the bottom of each header, the dogs being left in place in each case and the heels of the strong-backs being bolted to the boiler front by means of the studs in the handhole plates, as shown in the sketch. This gave a good, rigid brace for the work.

A channel bar 8 inches by 3 inches was placed on the boiler side of the apex of the strong-backs, flanges pointing boilerward, and extending from one strong-back to the other, as shown in the sketch. Four bars of iron 1 inch in diameter and 20 inches long were placed in the boiler, as shown in the sketch, to form rollers to take the weight of the element as it was shoved back and thus relieve the pressure on the baffles.

The upper and lower 4-inch nipples of the front header having been cut out, screw jacks were placed between the channel bar and the front header and were gradually set up. The whole element was thus moved aft, without much difficulty, until the defective back header was exposed in the rear of the boiler sufficiently to permit of being worked on. This is shown in the sketch at "B."

With the header in this position the oxy-acetylene welding outfit was again brought into play and the metal built up over the defect to a greater thickness and spread out more over the outer surface. It was impossible to put metal on the inner surface, since it was an under surface.

This being completed the element was forced back into place, the upper 4-inch tube rolled in, the upper and lower front 4-inch nipples renewed, the bracing removed and the casing replaced and boiler tested. A test of 400 pounds was applied without any indications of a leak, and subsequent service under forced draft has shown no derangement.

The baffles in the boiler had been put in alinement and held there by metal strips ¼ inch thick, 4 inches wide, and extending from the top row of 2-inch tubes to the bottom row and clamped to the tubes. This alinement made it possible for the tubes to slide through the baffles without breaking or deranging them, and also made a testing of the alinement of the baffles after the completion of the repairs a very simple and easy matter.

A comparison of the costs of the two methods is given below:

Method	Time	Material	Labor	Total Cost
Cut out header...........	6 days	\$103.00 (21/9/2)	\$44.52 (9/5/5)	\$147.52 (30/14/7)
Jack back header.........	4 days	\$6.96 (1/9/0)	\$32.68 (6/16/0)	\$39.64 (8/5/0)

Lieut. F. H. Sadler, U. S. N.

U. S. S. *Nebraska.*

United States Navy Specifications.—The new specifications of the United States Navy indicate a changed opinion as to the extent to which sulphur is detrimental in steel castings. Former specifications allowed a maximum of 0.05 percent sulphur in all carbon castings of grades A, B and C and 0.04 percent in nickel-steel castings designated as "special grade." In the new specifications grades A and B are subdivided into two classes—A and D, the high carbon, and B and E, the medium carbon relatively. A and B maintain the old limit of 0.05 percent sulphur and D and E permit castings to go as high as 0.07 percent sulphur. The two subclasses include castings of less importance than the others. For castings in grade C the limit is changed from 0.05 percent sulphur to 0.07 percent. The nickel-steel or special grade castings now have 0.05 percent instead of 0.04 percent sulphur as the limit. The requirements for tensile strength are reduced from a minimum of 90,000 pounds per square inch in nickel-steel to 85,000 pounds. The elastic-limit stipulation is 45 percent of the tensile strength in carbon castings, instead of a definite limit in pounds. The elongation requirements are advanced from 20 to 22 percent in the special, or nickel-steel, grade, and the bending bar required is 120 degrees instead of 90 degrees.—*American Machinist.*

Grab Dredgers

Fig. 1 shows two of the latest type of grab-dredgers made by Messrs. Priestman Bros., Ltd., Hull, fitted on a wooden pontoon at work in Sydney harbor. They take steam from a main boiler on the center of the pontoon. These grab-dredgers are capable of a working load of 8 tons at 40 feet radius and are equipped with two different designs of grabs, the grab-bucket and whole-tine types, the latter for dealing with hard material.

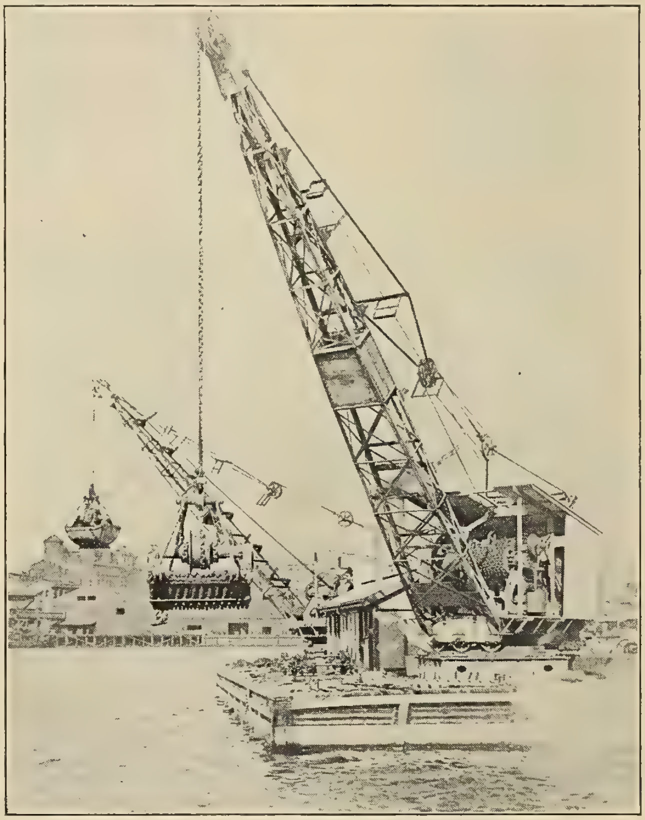


Fig. 1.—Grab-Dredger Pontoon

Priestman grab-dredgers have recently been fitted on self-propelled steam hopper barges, built by Mr. Joseph Constant, of London, for the Great Central Railway Company for their new port of Immingham. The dimensions of the vessels (Fig. 2) are: length, 132 feet 6 inches; beam, 28 feet 6 inches, with a hopper capacity of 600 tons.

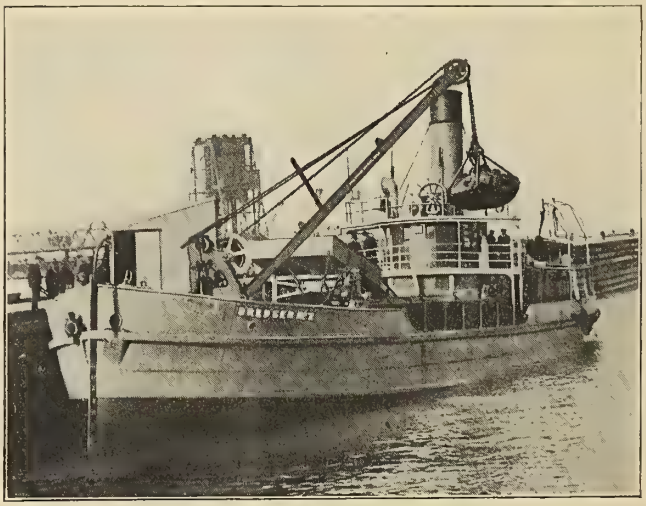


Fig. 2.—Grab-Dredger Hopper Barge

Marine Articles in the Engineering Press

Official Trials of New United States Destroyers—New Shipyard Tools and Methods—Electric Propulsion

Description of Trials of the Torpedo Boat Destroyer Downes.—By Lieutenant R. M. Griffin, U. S. N. The *Downes* is one of eight destroyers authorized by Congress on March 4, 1911. She is a twin screw vessel fitted with a combination of Curtis turbines and reciprocating engines and was built under contract by the New York Shipbuilding Company, Camden, N. J., at a price of $777,500 (£160,000). The hull is 300 feet long between perpendiculars, 30 feet 9 inches molded beam with a draft of 9 feet 11 inches on a displacement of 1,126 tons. The block coefficient is .418. The boilers are of the Thornycroft type arranged in pairs in two separate firerooms, each boiler being equipped with seven Schütte & Koerting fuel oil burners. A description is given of the main and auxiliary machinery and of the official trials. 1 illustration. 6,300 words.—*Journal of the American Society of Naval Engineers,* May.

An Air Fleet: Our Pressing Naval Want.—By Commander Thomas Drayton Parker, U. S. N. Before discussing the air fleet and its uses, a description is given of the various types of aircraft to be considered, including kites, balloons, aeroplanes and dirigibles. The paramount duty of both dirigibles and aeroplanes, in which their usefulness is proved by events during the present war, is reconnaisance. In addition to this, they are useful for screening and spotting. For offensive uses the weapons of the dirigible are rapid fire or machine guns, automatic rifles and bombs. For protection against aircraft the aerial gun is the main resource. After outlining the present position of aeronautics abroad, the point is emphasized that the present strength of our air fleet is: dirigibles, none; aeroplanes, including seaplanes, 23, which, compared with the strength of other nations, means that we are among the smallest of the minor air powers. The author makes a strong plea for the immediate construction of both the dirigibles and aeroplanes. 25,400 words.—*United States Naval Institute Proceedings,* May-June.

New Shipyard Tools and Methods.—By H. P. Phelps. This article describes the new tools and methods in use at the yards of the Newport News Shipbuilding & Dry Dock Company, where the equipment has been developed gradually, as the capacity of the yard has expanded. Of the three methods of driving machine tools in common practice, the centralized or single unit drive, the group drive and the individual motor drive, it has been found that the individual motor drive is by far the most satisfactory from an operating standpoint, but because of the fact that most machines take double the power to start them than is required to operate them after starting, with the consequent enormous first cost of equipping a shop complete with individual motor drives, it has been found advisable to install simple group drives in many instances. It is the intention of the management at present to scrap the very inefficient hydraulic pumps now installed for those of motor drive type, as it is assumed that a power saving of 100 percent will be accomplished by this change. As a result of investigations, the Newport News yard has installed a complete plant for the manufacture of gases for operating oxy-hydrogen and oxy-acetylene welding and cutting apparatus which has been found very efficient and economical for shipyard work. Two semi-automatic machines for milling turbine blading have also recently been installed with considerable savings for this class of work. In November, 1913, a tool-making department was organized, comprising a tool steel storage room and a heat treatment department, storage department, die-making department, machine department, grinding department and a tool storage room. The functions of this department include the purchase and selection of all the tool steel used at the yard and the manufacture complete, including the forging, machining, heat treatment and grinding of all the tools manufactured for use in the yard. Very favorable results have been obtained from this department. 5,000 words.—*The Journal of the American Society of Marine Draftsmen,* January.

The 250-Ton Floating Cranes for the Panama Canal.—Drawings are given of the original designs of the 250-ton floating cranes *Ajax* and *Hercules,* built by the Deutsche Maschinen Fabrik, A. G., of Duisburg. Steps are now being taken to repair the jib of the *Ajax,* which collapsed early in December last. The *Hercules,* however, was accepted by the canal authorities at the end of March and is now employed on work on the canal. The cranes were required to lift 250 tons at a reach of 21 feet over the ends and 22.3 feet over the side of the pontoon, and 100 tons at a reach of 80.1 feet over the end and 81.6 feet over the side of the pontoon. There were to be no moving counterweights. The pontoons are not self-propelling, but are furnished with warping capstans. They are very carefully designed with watertight compartments, any two of which can be flooded without impairing the stability of the crane. The pontoons are 150 feet 2⅝ inches long by 88 feet 9¾ inches wide, and have a depth of 15 feet 9 inches at the sides and 16 feet 8 inches at the center. Complete, each crane comprises about 2,869.3 tons of material made up as follows: Pontoon, 1,634.4 tons; electric plant, coal, water, etc., 173.7 tons; steel superstructure, 543 tons; machinery, 368 tons; counterweight motors, control gear, etc., 150.2 tons. 5 illustrations. 600 words.—*Engineering,* June 11.

Electric Propulsion for Battleships.—By Assistant Naval Constructor H. G. Knox, U. S. N. The reason why electric propulsion is being adopted, the author points out, is because other forms of reducing gear comprise a single ratio gear with a non-reversible turbine, which gives economical results for one speed only, whereas with electric propulsion economic, reliable, quick reversing drive is obtained at both high speeds and at cruising speeds. He maintains that only when mechanical engineers succeed in producing a reliable, quick reversing, two-speed gear capable of handling 7,000 horsepower at 160 revolutions per minute will the day of electric propulsion be over. In describing the details of electric propelling machinery, the author takes up first the alternator, then alternating current motors, induction motors, the phase-wound induction motor, and the double squirrel cage induction motor. Summing up the advantages of the various types of motors, the author points out that the double squirrel cage induction motor is by far the best solution for ship propulsion. 26 illustrations. 13,400 words.—*United States Naval Institute Proceedings,* May-June.

Description and Trials of U. S. Torpedo Boat De-

stroyer Nicholson.—By Lieutenant W. F. Cochrane, U. S N. The *Nicholson* is one of six destroyers authorized by Congress August 22, 1912, and is one of three built by William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., at a contract price of $842,000 (£172,500) for each vessel. The hull is 300 feet long between perpendiculars, 30 feet 4 inches molded beam, with a mean draft of 9 feet 5 inches on a displacement of 1,050 tons. The block coefficient is .426. Propulsion is by two Cramp-Zoelly turbines, arranged on two shafts, with a compound reciprocating cruising engine on the forward end of each shaft. Between the cruising engine and the turbine there is a hydraulically-operated friction clutch designed by Mr. J. F. Metten, chief engineer of the Cramp shipyard. A table is included, giving the dimensions of shafting, bearings, etc., as well as details and dimensions of the auxiliaries. Data from the standardization and other trials are given. 1 illustration; two tables. 3,600 words.—*Journal of the American Society of Naval Engineers,* May.

Steam Turbine Blade Fastenings.—By James A. Capstaff. Repeated tests of steam turbines have proved that the efficiency of a turbine varies with the blade speed and the number of rows of blades, and also that the number of rows of blades varies inversely as the square of the blade speed for a given efficiency. Increasing the number of revolutions per minute offers increased efficiency with smaller turbines, and the tendency is to develop along these lines. It is a question as to how far the peripheral speed of the blades can be increased and the size of the turbine reduced. The answer must be determined by the strength of the materials. Theoretically, the limit would be reached when the mean blade speed equals between .75 and .9 that of the steam in the case of a Parsons reaction turbine, and .5 in the case of a pure impulse turbine. Quite a common pressure drop through a turbine is from 265 pounds per square inch down to 28 inches vacuum. This drop in pressure represents a steam velocity of 4,200 feet per second. While the possibility of ever increasing the theoretical blade limit is remote, nevertheless the tendency is to go on increasing the blade speed. It should be noted that Parsons' turbines seldom exceed 550 feet per second at the mean diameter of the last expansion, Curtis as high as 700 feet per second, and De Laval 1,375 feet per second. All, however, are a long way behind the theoretical most efficient speed. With the increase of revolutions, if the diameter is kept down, the blade heights must run up. This cannot be done, however, without taxing the strength of the blade and its fastenings. A detailed description is given of the various methods of blade fastenings, including the Parsons, Westinghouse, Fore River, De Laval and the Lovekin methods. In Mr. Lovekin's method the rotor, or disk, is grooved with plain dovetailed grooves into which is inserted a tongued locking piece about 12 inches long. Alternately the blades and the distance pieces, whose roots are milled to a dovetail on one side and a recess on the other, are threaded on to this locking piece until the length is made up. Another piece of locking strip is inserted and more blades and distance pieces threaded on, and the operation repeated until the entire circumference of the groove is filled up, with the exception of a piece of locking strip equal in length to two blades and two distance pieces. After assembling one complete row, the locking ring is calked well down to make sure that the blading completely fills the groove. Mr. Lovekin's side locking piece is so designed that, in the process of calking, the roots of the blades and the distance pieces are first brought in contact with the bottom of the groove, and then the blades and distance pieces are forced bodily against the side of the rotor grooves. The bottom of the locking piece is under-cut so that in calking a spreading action takes place at the bottom and tightens the lower portion of the blading as well as the upper. Special mention is made of the admirable features of the Lovekin method, which are rigidity; great direct pulling strength; the fact that heavy calking is not required to give it its direct pulling strength; that full advantage has been taken of the best known method of assuring rigidity, namely, side calking; the blading operation is quick and so simple that the services of experienced bladers are not essential; it is foolproof; no special recesses are required around the circumference of the rotor grooves for the insertion of the blades (an item of importance in reblading); extended distance pieces, so valuable in strengthening the blades against bending, and providing a good steam line across the stage, can be used; perfect alinement of the blades in a row is assured, and there is no abrupt change of section or blade at the surface of the rotor. 24 illustrations. 5,500 words.—*Journal of the American Society of Naval Engineers,* May.

Heat Transmission and Tube Length in Marine Feed Water Heaters.—By Professor Leo Loeb, M. E. This article describes a method to develop the theory of heat transmission as applied to closed heaters operating on exhaust steam, and also the application of this theory with reliable data from tests of marine feed heaters to the preparation of design curves incorporating all the operating variables for a given type of heater. There is given first the general theory of heat transfer from steam to water, thermal resistances and a mathematical discussion of temperature differences or temperature gradients. The data used to determine the heat transfer in marine heaters were taken from tests on a Bureau of Steam Engineering heater and a Schutte & Koerting spirally corrugated film heater. The data thus obtained are incorporated in a number of design curves which permit a graphical solution of problems of feed heater proportions for a given type of heater. From the tests considered in the paper, the following conclusions were drawn: That closed feed water heaters developed for marine purposes have temperature gradients resulting from the general relation that heat transfer is proportional to some power of the temperature difference; that the numerical value of the exponent for the heaters tested is less than unity; a vertical tube permits higher rates of heat transfer than a horizontal tube due to the more effective disposal of condensate; film tube heaters give much higher rates of heat transfer than plain tubes, or tubes with retarders; the clearance between the tubes making up a film unit can be great enough to prevent excessive friction loss in the form of pressure drop without in the slightest decreasing the efficiency of the film agitation which renders this type more effective for heat transfer than a plain tube; air carried into the steam space of a feed water heater will seriously interfere with heat transmission in any type of heater, if allowed to accumulate for any considerable period of time; water film agitation is more important than steam side film agitation, and air free condensation are essentials to the maintenance of high rates of heat transfer. 20 illustrations, 13 tables, 3 appendices. 15,000 words.—*Journal of the American Society of Naval Engineers,* May.

The Ships of the United States Navy, 1776 *to* 1915.—By Robert W. Neeser. This is an installment of a series of articles giving an historical record of the ships now in service in the United States Navy and of their predecessors of the same name. This article deals with the *Arizona* and *Pennsylvania.* 3 illustrations. 5,800 words.—*United States Naval Institute Proceedings,* May-June.

New Books for the Marine Engineer's Library

A Noteworthy Treatise on Structural Design of Warships—Elementary Works on Mechanics and Valve Gears—Scientific Management

Beeson's Marine Directory of the Northwestern Lakes. Size, 6¾ by 9¾ inches. Pages, 288. Numerous illustrations. Chicago, 1915 Harvey C. Beeson. Price, $5.

This directory is now in its twenty-ninth year of publication and every effort has been made to make the data given regarding American and Canadian sailing, steam and gas-engined vessels on the Northwestern Lakes accurate and authentic in every detail. The lists of vessels give the rig, principal dimensions, date of building and the name and address of the owners in convenient tabulated form. A record of engines and boilers is included, together with lists of special types of vessels, such as lumber steamers, as well as the officials of various marine organizations on the Lakes. A very important feature of this year's volume is a port directory of Canadian harbors, published by authority of the Minister of Marine and Fisheries of Canada from a compilation of the Port Directory of Canada. The physical characteristics of each harbor are briefly described, indicating the docking and anchorage facilities as well as lights, port charges, etc. The book is replete with excellent illustrations of noteworthy ships and important marine events of the year, supplemented by brief articles regarding marine affairs on the Lakes and improved marine appliances.

Structural Design of Warships. By Professor William Hovgaard. Size, 6¾ by 9¾ inches. Pages, 384. Illustrations, 186. New York, 1915: Spon & Chamberlain. Price, $5.50 net. London, 1915: E. & F. N. Spon, Ltd. Price, 21s. net.

With public attention focused by the present European war upon naval strength and the relative value of different types of warships, this volume by Professor Hovgaard, late commander of the Royal Danish Navy, and now professor of naval design and construction, Massachusetts Institute of Technology, is particularly timely. The book is based on a series of lectures prepared for a course in naval construction, which was established by the Massachusetts Institute of Technology in 1901 for officers of the United States Navy detailed to take this course in preparation for duty as naval constructors. Although the work was prepared chiefly as a text-book for students of naval construction, it goes considerably beyond the limits of ordinary text-books, and in the theoretical treatment of the subject much is presented that is new.

The early chapters deal with longitudinal strength, transverse strength and the strength of individual girders. Following this, there are chapters on the strength of a rectangular plate under fluid pressure, and of columns and plating under compression. Seldom has the application of scientific principles to structural design been more carefully worked out than in the treatise which Professor Hovgaard gives of the design of the structural members of warships. The results are of immediate practical value to anyone who has to do with design problems of this nature.

In the chapter on riveting and calculations for riveted joints, the author most carefully investigates the method of failure of all forms of riveted joints commonly used in hull construction, and extends the investigation to the riveting of bulkhead liners and doubling plates—a subject on which little discussion is available.

Shell plating, framing, decks and bulkheads are in turn exhaustively treated, and, in the theoretical treatment in these chapters, much is given that is novel, while in the chapters on practical application the author advances a number of suggestions for new structural features.

Professor Hovgaard's methods of investigating the problems of strength in structural members are in a measure known to readers of this magazine from the papers which he has presented before the Society of Naval Architecture and Marine Engineers and the Institution of Naval Architects. The present volume brings into readily accessible form the results of exhaustive investigations and research from sources of information which are widely scattered, and in most of the subjects discussed the different practices employed by various nations in warship design are compared.

Work, Wages and Profits. Second edition. By H. L. Gantt. Size, 5 by 7¼ inches. Pages, 312. Illustrations, 27. New York, 1913: The Engineering Magazine Company. Price, $2.

In bringing out a second edition of this well-known volume, the subject matter has been thoroughly revised and enlarged by the inclusion of additional instances of the application of scientific methods to labor problems, and also by giving more detailed developments of some features of the work and the summation of the argument into a comprehensive and complete outline of a plan of systematic management, based on the policies and methods defined by the author.

Valve Gears. By Prof. Charles H. Fessenden. Size, 6 by 9 inches. Pages, 170. Illustrations, 171. New York, 1915: McGraw-Hill Book Company, Inc. Price, $2 net.

Only steam engine valve gears are discussed in this book, and the subject matter is presented in the form of an elementary treatise for use principally as a text-book for students in an engineering college. The Zeuner and Bilgram diagrams are both used throughout the book and are given almost equal consideration. Some of the most useful constructions belonging to the Reuleaux diagram have been incorporated in the Zeuner solutions in order to avoid introducing a third diagram.

Elementary Mechanics for the Practical Engineer. By John Paul Kottcamp. Size, 5½ by 8¼ inches. Pages, 181. Illustrations, 85. New York, 1915: McGraw-Hill Book Company, Inc. Price, $1.50 net.

The subject matter of this book comprises a series of thirty lessons published in *Power* as part of an engineer's study course. The aim of the entire course is to present only those principles of mechanics which could be directly applied to the various phases of power plant operation. The problems given in the book were selected with this point in mind. The book is a clear exposition of a branch of science which should be understood by every practical engineer.

The Fore River Log.—A 16-page magazine known as the *Fore River Log,* published in the interests of the employees of the Fore River Shipbuilding Corporation, Quincy, Mass., made its first appearance in May of this year. The various activities of the community of 5,000 men who comprise the shipyard force are described and illustrated in a most interesting manner.

Shipbuilding and General Marine News

**Contracts for New Ships—Marine Terminal Improvements—
Recent Launchings—Improved Appliances—Personal Items**

New York merchants and capitalists, according to reports, have organized a syndicate with a capitalization of $100,000,000 (£20,500,000) to build a large number of vessels for use in the foreign trade. In addition to this syndicate, two other projects are being considered, each involving the construction of about ten large freight carriers. One of these is interested in the West Indian trade. Because of these projects and other inquiries out for over fifty steam vessels, the prospects for establishing additional shipyards in the United States are very promising.

That an important project is on in connection with the William Cramp & Sons Ship & Engine Building Company, Philadelphia, is indicated by the sale of a large amount of its stock and a sudden rise in its price from 27 to over 60 during the past month. Among other new shipyard projects is the reopening of the old Crescent Shipyard at Elizabethport, N. J., now known as Samuel Moore & Sons Company. It is understood that this plant will be considerably enlarged and will specialize in the construction of submarines. The old Roach shipyard property at Chester, Pa., changed hands recently and an English syndicate will re-establish this yard for the construction of steel hulls. The New Haven Shipyard Company, recently organized at Bridgeport, Conn., has taken over the shipyard of J. E. Mar & Son Company, West Haven, Conn. There is also a report that the Shooters Island Shipyard will be reopened.

The fifty or more inquiries now out for new vessels are for tonnages ranging from 4,000 to 18,000, and they include inquiries from Great Britain, Norway, France, Germany, Spain, Russia, Denmark, Portugal and China. At the present time American shipyards are turning out about 175 vessels a month and two or three of the largest yards on the Atlantic coast are unable to take an order for delivery inside of 24 to 30 months, as they each have enough work on hand to keep over 6,000 men employed. In a number of yards there is a shortage of labor and high wages and continuous employment are offered to artisans of all classes.

Recent Contracts Placed with Atlantic and Pacific Coast Yards

The Fore River Shipbuilding Corporation, Quincy, Mass., has received a contract from the Luckenbach Steamship Company, New York, to build a freight steamship 437 feet long.

William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., has has received a contract from the Mexican Navigation Company, Vera Cruz, Mex., to build a passenger and freight steamship at a cost of about $800,000 (£164,000). It is also reported that this company has received an order from the Russian government for several small boats.

The Staten Island Shipbuilding Company, West New Brighton, N. Y., has received an order through Eads Johnson, New York, from the Huasteca Petroleum Company, New York, for a 10,000 barrel oil barge.

The Maryland Steel Company, Sparrows Point, Md., has secured an order from the Munson Steamship Line, New York, for two freight steamships, each of about 7,000 tons. These are understood to be in addition to the contracts for two freighters for this company placed some weeks ago.

The New York Shipbuilding Company, Camden, N. J., has recently received orders to build two tank steamers to cost about $1,000,000 (£205,000).

The John W. Sullivan Company, New York, has received a contract to build a steam lighter for the Delaware, Lackawanna & Western Railroad Company, New York. The hull of the vessel will be constructed by the New Jersey Dry Dock Company, Elizabethport, N. J.

A. C. Brown & Sons, Tottenville, N. Y., has a contract to build a wooden tug for the Carrol Towing Company, New York.

Hampton C. Ellis' Son, Tottenville, N. Y., is building a 50-foot combination tug and passenger boat for the Hewitt Bearing Metal Company, Newark, N. J.

The Greenport Basin & Construction Company, Greenport, N. Y., has received a contract to build twelve 60-foot, 25-knot power boats.

The Charles R. McCormick Company, San Francisco, Cal., has placed a contract on the Atlantic coast for a lumber steamer 415 feet long, and this company has also ordered two auxiliary power schooners to be built on the Pacific coast.

The Union Iron Works, San Francisco, Cal., has received a contract from the Union Oil Company of San Francisco to build an oil tank steamer at a cost of about $1,000,000 (£205,000).

New Vessels Ordered from Shipbuilders on the Great Lakes

The Great Lakes Engineering Works, Detroit, Mich., has received an order from the Clyde Steamship Company, New York, for three single screw freight steamers designed by Theodore E. Ferris, naval architect, New York, which will cost about $175,000 (£36,000) each. This yard also has contracts from A. L. Crosthwaite, New York, for a steamer for the coast trade and from a New York firm for a steamer about 250 feet long.

The Collingwood Shipbuilding Company, Collinwood, Ontario, has a contract to build a steel tank steamer for the Imperial Oil Company, Toronto, Ontario.

Bath Shipyards Busily Engaged with New Work

The shipyards of Bath, Me., have more work on hand than they have had for many years past. The Kelly-Spear Company is building three large wooden barges for the coal-carrying trade. The Gardner C. Deering Company is building a five-masted schooner, and Percy & Small will shortly begin construction on a four-masted schooner. The Bath Iron Works will soon begin work on the two torpedo boat destroyers and a large steam yacht, contracts for which were received some months ago.

Frank S. Bowker & Son, Phippsburg, Me., is building a three-masted wooden schooner.

Shipbuilding Contracts Soon to be Placed

Several orders are about to be placed by various departments of the Federal Government, outside of navy contracts, for which bids will be asked in July or August.

George Simpson, naval architect, New York, is preparing plans for a large steel freight steamship, contract for which will shortly be let by the Union Sulphur Company, New York.

The New York & Cuba Mail Steamship Company (Ward Line), New York, will shortly place a contract for two large steel passenger and freight steamships, designed by Theodore E. Ferris, naval architect, New York.

Eads Johnson, naval architect, New York, is preparing designs for several vessels and will shortly ask for bids.

M. Moch, superintendent of the Richmond-San Rafael Ferry Company, San Rafael, Cal., will shortly place a contract for a ferryboat to cost about $125,000 (£25,600).

Two large banana companies in New Orleans, La., have combined and will shortly be in the market for fruit steamers. Mr. John Beninato, of New Orleans, is president of the company.

New Steamboat Companies Organized to Operate on the Mississippi River

The Inland Navigation Company has been organized with a capital stock of $9,000,000 (£1,840,000) to build and operate steam barges and other vessels on the Mississippi river.

A company has also been organized with a capitalization of $1,000,000 (£205,000) to be known as the Chicago, St. Louis & Gulf Transportation Company, to run a fleet of river boats between Chicago and New Orleans.

The Ohio River Improvement Association, Cincinnati, Ohio, has made plans to build and operate a line of freight steamers between that city and New Orleans. Both steamboats and barges will be built for this purpose, and it is understood that the vessels will be larger than anything ever used on the Ohio river.

Marine Terminal Projects

Dock Commissioner R. A. C. Smith, of New York City, recently opened bids for the construction of a new pier at the foot of Thirtieth street, New York, and also for a new pier at Twenty-ninth street, Brooklyn, N. Y., to be occupied by the United States Steel Products Company.

The Department of Wharves, Docks and Ferries, Philadelphia, Pa., is having plans prepared for a double-deck reinforced concrete pier 250 feet by 900 feet, to be erected at the foot of McKean street.

The Stone & Webster Engineering Corporation, Boston, Mass., has a contract for the construction of a pier for the Galveston Wharves Company, Galveston, Tex.

D. L. Taylor Company, Inc., Medina, N. Y., has received a contract to build a public wharf at Dunkirk, N. Y., to cost about $70,000 (£14,300).

The municipal authorities of the city of Baltimore, Md., realizing the need of larger dock facilities, are considering a proposal to construct and equip with mechanical freight handling appliances eight municipal piers.

The city of Beaumont, Tex., has voted in favor of a $100,000 (£20,500) bond issue to complete proposed wharf, dock and terminal improvements.

The city of Evanston, Ill., will soon vote on a $50,000 (£10,250) bond issue for the construction of piers.

Herbert D. Mendenhall, consulting engineer, Lakeland, Fla., has been retained to design and install the wharves and terminals of the Commodores Point Terminal Company. The improvements include the construction of one mile of wharves on the St. Johns river.

It is reported that the St. Louis & San Francisco Railway Company, St. Louis, Mo., will spend $30,000 (£6,180) in the construction of a wharf along the Warrior river at Cordova, Ala.

The Baltimore & Ohio Railroad Company, Baltimore, Md., is having plans prepared for a coal pier to be built at Curtis Bay. This pier will be about 700 feet long and will cost about $1,000,000 (£205,000).

The City Commission of Orange, Tex., will soon call an election to vote on a bond issue of $150,000 (£30,800) for building wharves and docks.

Baltimore Shipbuilding Plant Reorganized

The Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., recently organized, has taken over the two shipbuilding plants and other properties of the Skinner Shipbuilding & Dry Dock Company. The officers of the new company are: President, Thomas H. Bowley, chairman of the board, Baltimore Trust Company; vice-president and general manager, Holden A. Evans, formerly naval constructor U. S. N.; assistant manager, J. M. Willis; treasurer, William C. Seddon; secretary, William W. Coe. Mr. Evans, who has had charge of the Skinner Shipbuilding & Dry Dock Company for the past year, will be the active manager of the new company. The plant is equipped with two dry docks, 600 and 437 feet long, respectively, and in addition there are shops and equipment for all classes of repair work and for the construction of tugs, torpedo boats, submarines and other vessels not exceeding 340 feet in length. The plant will be greatly improved and it will be the aim of the management to make it efficient in every department.

Electrical Equipment at the Smith Shipbuilding Plant, Norfolk, Va.

The electrification of the F. O. Smith Shipbuilding & Dry Dock Company's dry dock at Norfolk, Va., is a notable example of the saving that can be effected by the use of electricity in shipyards. Previous to July, 1912, the dry dock was operated by old-fashioned steam-driven bucket pumps. With this equipment practically half a day was required to make a haul, and occasionally trouble was experienced with the operating machinery. In seeking to improve the operation and shorten the time required to lift a vessel, the owners decided to replace the steam equipment with electrically-driven pumps. Accordingly, twelve 20-horsepower, 1,135 revolutions per minute Westinghouse electric vertical motors coupled to 10-inch Morris centrifugal pumps were installed.

The installation met with such immediate success that in February, 1915, another section was added and six additional pumping units, duplicates of those previously installed, were purchased and placed in position. The dock will accommodate vessels not over 260 feet long on the keel blocks or 3,000 tons deadweight. It is now possible with this new equipment to lift a vessel high and dry in seventeen minutes at an energy cost of about $4.50 (18/9), whereas with the old equipment it required half a day and cost from $12 (2/10/0) to $15 (3/2/6).

In addition to the electrically-driven pumps on the dock, the shipyard is fitted up with a very complete line of shipbuilding machinery, including air tools, modern machine,

boiler and blacksmith shops, a marine railway with a concrete foundation (said to be the only one of the kind in the world), a saw mill and a Westinghouse electric welding outfit equipped also for cutting.

River Steamer Converted to Freight Barge

The freight and passenger steamer *Capital City*, built forty years ago at Wilmington, Del., is about to end her career in the freight and passenger service from Washington, D. C., to the lower Potomac River points. All of her upper works and machinery have been removed and the hull will be converted into a freight-carrying barge for service on the Chesapeake Bay and its tributaries. During her long career on the Potomac River this vessel proved herself one of the most reliable steamers in the river service.

Battleship Arizona Launched

The United States battleship *Arizona*, sister ship of the *Pennsylvania*, was launched at the navy yard, New York, on June 19. The vessel is of 31,400 tons normal displacement, with a length of 600 feet on the waterline, a beam of 97 feet and a mean draft of 28 feet 10 inches. The main armament will consist of twelve 14-inch guns mounted in four triple turrets on the centerline. Propulsion is by Parsons turbines.

New Steam Lighter

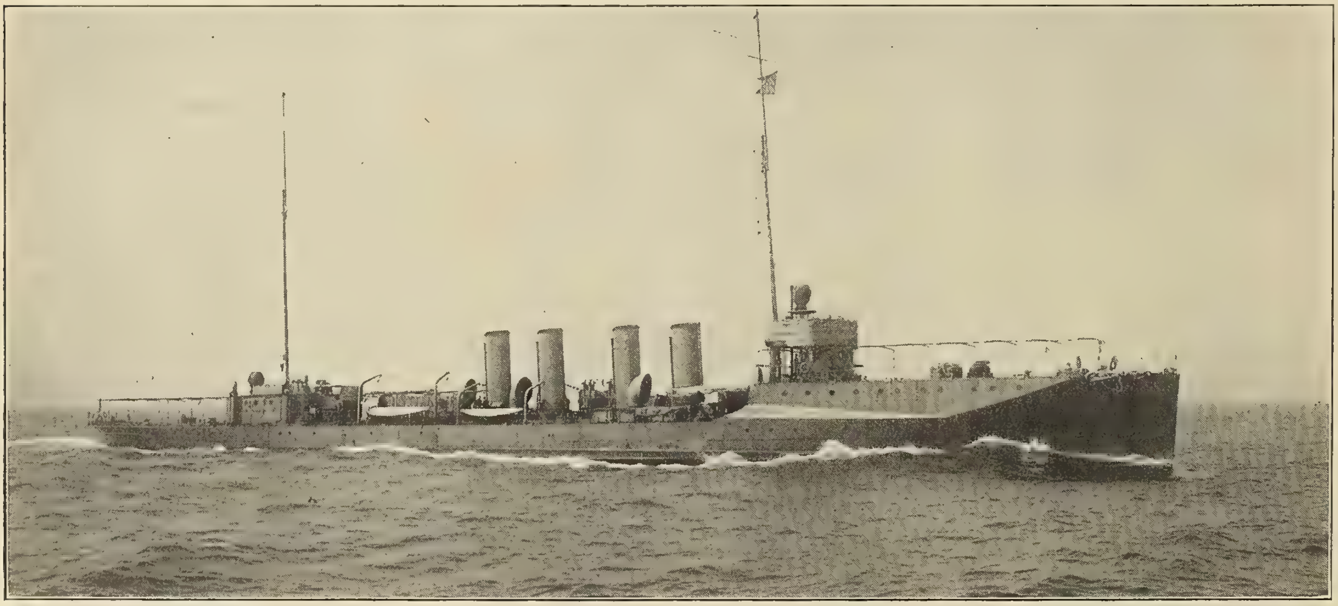
Verdon & Co., of Staten Island, N. Y., has recently delivered to the Rock Plaster Manufacturing Company, of New York, a new steam lighter, called the *Robert L. Stevens*, which was built from designs by Cox & Stevens, naval architects, New York. The lighter is designed to carry practically all of her cargo on deck, and accordingly the machinery, deck house and derrick have been kept as far aft as possible and the lines have been designed so she will trim properly when light or loaded.

The hull is 97 feet long overall, 28 feet 6 inches beam molded, 10 feet depth of hold and 9 feet 6 inches draft. She has a cargo carrying capacity of 160 tons. Propulsion is by a single cylinder engine, 18 inches diameter by 24 inches stroke, driving a cast iron propeller 7 feet 8 inches diameter by 10 feet pitch. Steam is supplied by a leg type boiler 9 feet diameter by 13 feet long, built by Heipenshausen Bros.

Steam Lighter *Robert L. Stevens*

LAUNCH OF THE WAINWRIGHT.—The United States torpedo boat destroyer *Wainwright* was successfully launched at the works of the New York Shipbuilding Company, Camden, N. J., June 19. The new destroyer is a sister ship to the *Jacob Jones*, recently launched at the same yard, and has a length overall of 315 feet and a beam of 30 feet 6½ inches. Her armament includes four 4-inch 50-caliber rapid fire guns and four 21-inch torpedo tubes.

SHIPBUILDING RETURNS.—The Bureau of Navigation, Department of Commerce, reports 173 sailing, steam and unrigged vessels of 19,494 gross tons, built in the United States and officially numbered during the month of May.



(Photograph by the New York Shipbuilding Company)

U. S. S. *Ericsson* Making a Speed of 30.41 Knots on Her Trial Trip

ENGINEERING SPECIALTIES

Submarine Photography

Submarine photography, or the taking of pictures, both stationary and moving, under water, is made possible by an invention of Charles Williamson and his two sons, of Norfolk, Va., which consists of a collapsible accordion-like

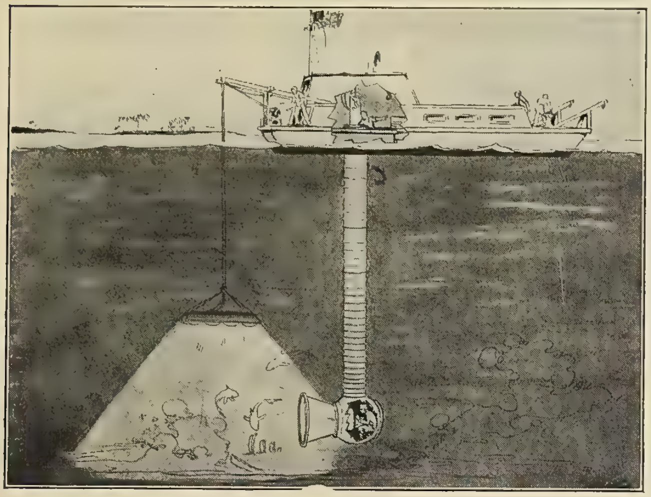


Fig. 1.—Williamson Submarine Photographic Apparatus in Actual Operation

submarine tube of waterproof canvas and rubber, 3 feet in diameter, braced at regular intervals by iron rings. This construction permits the passage of a person down the tube, and its flexibility permits it to be dragged along by a vessel. The top of the tube remains open at the deck and the lower end extends down into the water and expands into a chamber about 5 feet in diameter, one side

Fig. 2.—Photograph of Diver Exploring Wrecks of Sunken Ships

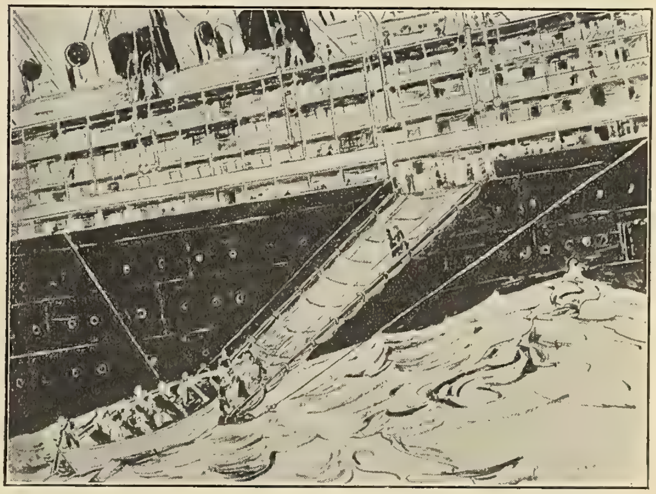
of which is provided with an observation glass window through which the pictures are taken. The space in the chamber is sufficient to admit two men, one to operate the camera and one to control the movement of the tube, which is effected by chains operated from the deck of the boat. Fresh air is provided by a simple device, enabling the operators to work in comfort.

Artificial illumination under the water for taking the pictures is secured by a battery of nine Cooper Hewitt quartz lamps, each having 2,400 candlepower. This lamp consists of a short tube of pure fused quartz or silica containing vapor of mercury, which is made luminous by the passage through it of an electric current. The essential parts of the lamp are the quartz burner and the auxiliary. The former is the light-giving tube, its support and enameled reflector, while the latter consists of the necessary tilting mechanism and coils for starting and maintaining the mercury arc. The auxiliary is kept on board the boat, and the burner with its reflector holder is mounted in a casing that is placed in a frame and lowered into the water.

The construction of the lamp and its method of installation are shown in Fig. 1. Photographs and moving pictures have been made through the water by the method described for a distance of 100 feet. The photograph (Fig. 2) of the diver exploring an old wreck of a ship, 50 feet away from the camera, indicates one of the numerous practical uses to which this most important development may be put.

Emergency Marine Gangway

Captain Arthur N. McGray, of 119 West Seventy-first street, New York, has devised a scheme for the safe disembarking of passengers and crew from a ship in distress in a rough sea, which has the merit of being extremely simple to construct and handle. As shown by the illus-



Emergency Gangway in Operation

tration, it consists of an inclined gangway constructed of two booms with floats at the outboard ends to buoy them at the surface of the water. The booms are stayed by guy ropes and a wire net is spread between them over which, it is claimed, the passengers can safely pass. Sufficient slack is provided in the network at the outboard end so that the bow of the lifeboat can ride on the net. With a vessel in distress lying in the trough of the seas, the emer-

gency gangway would be lowered on the lee side, and by keeping the lifeboat bow-on to the rescue net the boat would be in the best possible position to ride the waves.

Plans for Government Steamer Surveyor

Preparations are being made by the Department of Commerce, Washington, D. C., for the reception of bids for the proposed new coast and geodetic survey steamer *Surveyor*. This vessel, of the ocean-going type, is to be used in surveying the work in Alaskan waters. Plans and specifications are now being prepared and will be ready by July 1. The vessel will be built along standard lines, and will be of a thoroughly serviceable type. Her equipment will also be of a standard type. This decision was reached in order that the construction of the boat should not be made unduly expensive by the use of special equipment. The *Surveyor* is to be 186 feet long, with a beam of 35 feet and a displacement of 1,000 tons. She is to burn crude oil and is to have a speed of 12 knots and a cruising radius of 8,000 miles. Accommodations will be provided for 11 officers and a crew of 56. Her wireless equipment will have a sending radius of 300 miles. The cost is not to exceed $220,000 (£45,000).

PERSONAL MENTION

Operating Engineers

John Clark, of New Orleans, La., has been appointed assistant engineer on the lake steamer *Hanover*.

M. J. Kennedy, of New Orleans, La., has been appointed assistant engineer on the ocean-going tug *Security*.

R. P. Petrie has been appointed chief engineer of the steamship *Isthmian*, which sailed recently for the Pacific Coast.

A. C. Thorsen, formerly chief engineer of the steamer *Honduras*, has been appointed chief engineer of the *Vigilancia*.

William Rigney, of New Orleans, La., has been appointed second assistant engineer of the steamer *Norman Bridge*.

Lorrain A. Horton is chief engineer of the sea-going yacht *Utawana*, owned by Commodore Armour of the New York Yacht Club.

J. T. Snow, chief engineer, and N. Morrison, first assistant engineer, have sailed on the steamship *Californian* for Buenos Aires.

H. F. Boardman, chief engineer, and J. F. Burke, first assistant engineer, have sailed on the steamer *Oregonian* for Rio de Janeiro.

Euler Brown has been appointed chief engineer of the steamer *Mohawk*, engaged in work on the New York State Barge Canal at Little Falls, N. Y.

W. H. Philbrook, formerly first assistant engineer of the steamer *Honduras*, has been appointed chief engineer of this vessel, succeeding A. C. Thorsen.

Charles Bortle has been appointed chief engineer of the twin-screw steamer *Julia Saffard* of the Albany & Troy Line, which went into service on May 30.

Sandy Andas, of Norfolk, Va., has been appointed assistant engineer of the steamer *St. Johns*, running on the Colonial Beach route from Washington, D. C.

Edward Fitzgerald, formerly chief engineer of the steamer *St. Johns*, has been appointed chief engineer of the *Dreamland*, running between Baltimore and Chesapeake Beach.

John F. McCoy has been appointed chief engineer of the steamer *Highlander*, which the McAllister Steamboat Company of New York has placed in the Hudson River excursion trade.

James Featherly, formerly an engineer in the Murray Line, has accepted a position as chief engineer of the tug *James H. Scott*, which went into commission on June 1, doing harbor work at Albany, N. Y.

George T. Cahill, secretary of the Marine Engineers' Beneficial Association No. 63, has been appointed chief engineer of the Federal Building at Albany, N. Y., having entered the Civil Service on June 1.

John Shultz, formerly first assistant engineer of the steamer *Coe F. Young*, has been transferred to the tug *Empire*, which is engaged in towing for the Great Lakes Dredge & Dock Company at Troy, N. Y.

John Houser, chief engineer of the towboat *George C. Adams* of the Cornell Towing Line, has been transferred to the steamer *Coe F. Young*. The *George C. Adams* has been laid up at Rondout, N. Y., for repairs.

Edward Washburn, formerly chief engineer of the Albany Carbonic Gas Works at Albany, N. Y., has been appointed chief engineer of the steam tug *Marguerite* of the Great Lakes Dredge & Dock Company.

Robert P. Cook, chief engineer of the Central Hudson Steamboat Company, with a record of fifty-three years of service on the Hudson river as a marine and superintending engineer, has retired from active service.

Frank D. Gatter, formerly chief engineer of the steamship *Portland*, which recently left San Francisco for Europe, has been appointed first assistant engineer of the steamship *Menoa* of the Matson Steamship Company.

Elsworth B. Mealy has been appointed chief engineer of the steamer *Florence W.*, which is engaged by the Vanderson Contracting Company in construction work on the New York State Barge Canal at Mechanicsville, N. Y.

George Butler, of Alexandria, Va., is chief engineer of the steamer *Pontonier*, which is owned by the United States Government for the use of the United States Engineer Corps. Captain Frank Lucket is in command of this vessel, succeeding Captain J. A. Beacham, resigned.

E. P. Evans is chief engineer and Joseph Nash assistant engineer of the tug *Mitchell M. Davis*, which has just been chartered by a Philadelphia firm and will probably be engaged on Delaware Bay during the summer. The tug is owned by the Taylor Bros., Washington, D. C., and commanded by Captain R. T. Fowks.

George Foss is chief engineer and Joseph Archer and William Stone assistant engineers of the steamer *Isis*, recently purchased by the Department of Commerce for coast and geodetic survey work. This vessel, under the

command of Captain Paul Whitney, recently sailed from Washington, D. C., to take up the coast survey work.

William S. Werling is in charge of the engine room of the torpedo boat *Barney*, commanded by Lieutenant Loraine Anderson, which recently arrived in Washington, D. C., where she will remain for a period of about three months, during which time she will be engaged in giving the District of Columbia Naval Reserve practical experience in torpedo work and mine planting.

R. L. Brown is chief engineer and H. S. Johnson assistant engineer of the steam tug *Advance*, the most powerful tug of the fleet, owned by the Taylor Bros., Washington, D. C. This tug has been chartered by a New York firm and is under the command of Captain O. L. Crowder.

Dennis Ethridge, of Norfolk, Va., has been appointed chief engineer of the steamer *Wakefield*, with James Richardson of Washington, D. C., as his assistant.

Naval Architects, Consulting Engineers and Shipyard Officials

Rear Admiral Henry T. Mayo, U. S. N., has been selected for appointment as the first vice-admiral under the provisions of the naval act approved March 3, 1915.

At the commencement exercises of Columbia University, New York, the honorary degree of Doctor of Science was conferred upon Rear Admiral Robert Stanislaw Griffin, engineer-in-chief of the United States Navy.

Prof. Harold A. Everett, associate professor of naval architecture at the Massachusetts Institute of Technology, Boston, Mass., has resigned to take up the duties of professor of marine engineering in the Post Graduate Department of the United States Naval Academy, Annapolis, Md. Professor Everett graduated from the Massachusetts Institute of Technology in 1902 and since then has been continuously associated with the Institute as instructor, assistant professor and finally as associate professor of naval architecture. Professor Everett is the author of a number of papers on marine engineering subjects presented before the Society of Naval Architects and Marine Engineers and is well known to the readers of this magazine as the editor of the "Questions and Answers" department.

The Hawkins-Hamilton Company, Peoples National Bank Building, Lynchburg, Va., has been appointed as the representative of the Terry Steam Turbine Company, Hartford, Conn., for the State of Virginia.

J. Harry Mull, general superintendent of William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., made the voyage to the Pacific Coast on the turbine steamship *Northern Pacific* when she was delivered to her owners.

Merton A. Pocock has been appointed district sales manager of the Terry Steam Turbine Company, Hartford, Conn., for the territory included in the States of Minnesota, North Dakota and South Dakota, with headquarters in the Endicott Building, St. Paul, Minn.

H. L. Ferguson, vice-president and general manager of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., recently announced the following changes in the officers of that company made since the death of President A. L. Hopkins, who was lost on the *Lusitania*: F. P. Palen, assistant general manager, is transferred to the New York office of the company. W. H. Benson has been appointed assistant to the general manager, and is transferred to the general manager's office. E. I. Cornbrooks is appointed superintendent of hull construction.

OBITUARY

John Samuel White, chairman of Messrs. J. Samuel White & Company, Ltd., the famous shipbuilding and engineering firm of East Cowes, died on May 14, aged seventy-seven years.

Thomas Johnson, former superintendent of the Harlan & Hollingsworth Company, Wilmington, Del., died at his home at Belle Haven, Va., on June 5, aged eighty-seven years. At the age of twenty-two he entered the employ of the Harlan & Hollingsworth Company as a helper in the boiler shop. From this position he rose to become superintendent of the shipyard. He retired in 1894, but two years ago he superintended the construction of two steamboats at Sparrows Point, Md.

S. Cornelius Midlam, formerly chief engineer of the Hudson River Day line steamer *Albany*, died at his home in New York city on June 2 at the age of eighty-four. Mr. Midlam retired two years ago, having served for twenty-seven years as chief engineer of the steamer *Albany*. At that time he was probably the oldest marine engineer in active service. Before entering the Hudson River Day Line service, Mr. Midlam had served in the United States Navy and during the Civil War was chief engineer of several war vessels.

Rear Admiral Benjamin F. Isherwood, U. S. N., retired, formerly engineer-in-chief of the United States Navy, died at his home in New York on June 19, at the age of ninety-two. Admiral Isherwood entered the navy in 1844 and served during the Mexican war and later with the Asiatic squadron. At the begnning of the Civil War he was appointed by President Lincoln chief of the newly organized Bureau of Steam Engineering and was intrusted with the work of building up a steam-driven navy. His work in this direction, bitterly attacked at the time, stands to-day as one of the most brilliant contributions to the development of steam engineering. In recognition of his achievements the steam engineering and naval construction building at the Naval Academy has been named Isherwood Hall and a bronze bust of the officer has been placed over the entrance bearing an inscription testifying "to his services to his country, to his profession and to his corps and to his international reputation in the science and art of engineering."

Among the engineers of the Cunard liner *Lusitania*, which was torpedoed off the Old Head of Kinsale on May 7, the following were lost: Archibold Bryce, chief engineer; W. T. Smith, intermediate second engineer; W. Hetherington, third senior third engineer; W. G. Fairhurst, first intermediate third engineer; W. H. Cole, second intermediate third engineer; T. R. Duncan, senior fourth engineer; R. E. Jones, Junior fourth engineer; W. A. Anderson, senior fifth engineer; S. C. Kelly, intermediate fifth engineer; J. H. Hayes, junior fifth engineer; J. Beggs, senior sixth engineer; D. Morrice, junior sixth engineer; J. Lee, senior seventh engineer; A. F. Wheelhouse, junior seventh engineer; J. F. Paton, steering engineer; C. S. Fenton, dock engineer; W. Quarrie, ventilating engineer; G. Latham, second electrician; R. Gould, first boiler maker; R. McLean, plumber.

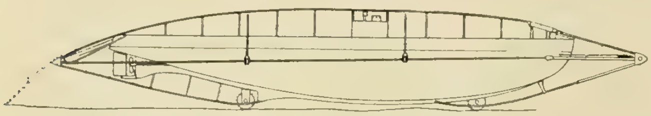
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Derbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,135,537. SIMON LAKE, OF MILFORD, CONN., ASSIGNOR TO THE LAKE TORPEDO BOAT COMPANY OF MAINE, OF BRIDGE-PORT, CONN., A CORPORATION OF MAINE.

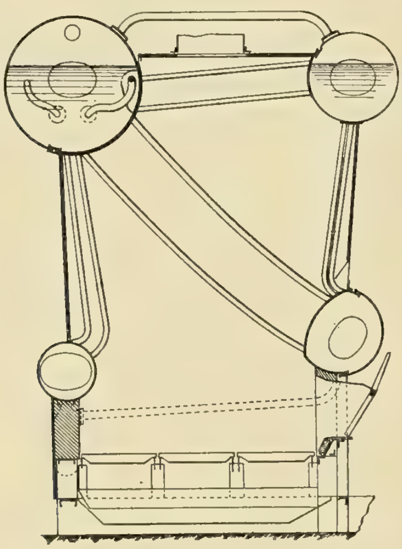
Claim 8.—The combination with a submarine boat, of combined steering and propelling wheels mounted in the boat and adapted to be projected below the keel thereof, a fender journaled in the sides of the bow of the boat, and comprising converging hollow arms having their



outer ends connected by a conical casting, means for controlling the position of said fender, fender rails extending from said fender over the deck, along the sides and under the keel of the boat, said rails having their after ends terminating aft of the stern of the boat, and antennæ connected to the casting of said fender, substantially as and for the purpose specified. Eighteen claims.

1,135,636. WATERTUBE MARINE BOILER. MARIO VALLINO, OF GENOA, ITALY, ASSIGNOR TO SOCIETA ANONIMA ITALIANA GIO. ANSALDO & CO., OF GENOA, ITALY.

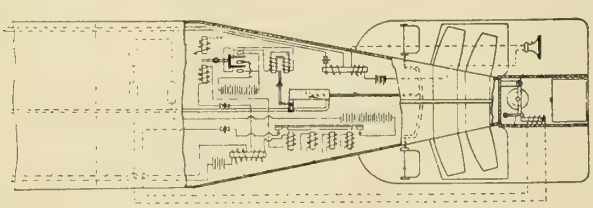
Claim 1.—In a watertube steam boiler of the type hereinbefore specified, the combination with a rear transverse upper steam and water drum, and a front transverse upper steam and water drum of connecting tubes exposed to the hot furnace gases, connecting the water space



of said rear upper drum with the water space of said front upper drum, a chamber in the water space of said rear upper drum inclosing the orifices of said connecting tubes, and feed water supply pipes for delivering into or outside the said chamber, whereby said connecting tubes are enabled to operate if desired, as the tubes of an economizer for heating the feed water before delivering same into said front upper drum.

1,137,222. TORPEDO AND OTHER SUBMARINE APPARATUS. KARL OSKAR LEON, OF GOTTENBORG, SWEDEN, ASSIGNOR TO LEON STEERING DEVICE COMPANY, OF BROOKLYN, N. Y., A CORPORATION OF NEW YORK.

Claim 8.—The combination with a submarine vessel of a pair of receivers adapted to be actuated by like vibrations of the water, a steering

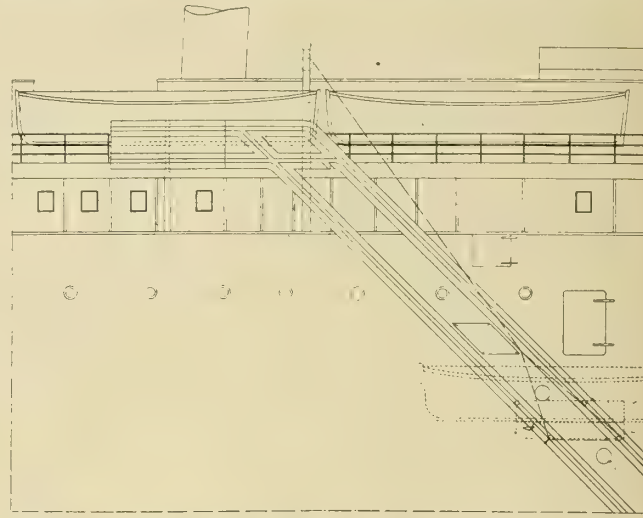


device for the said vessel, controlling means for the said steering device, electric circuits each including one of the said receivers, transformers each having a primary winding included in one of the said circuits, electromagnets each connected in circuit with the secondary winding of one transformer, and means operated by the said electromagnets for actuating the controlling means to steer in one or the other direction toward the source o vibrations, according as one or the other electromagnet is ener Fourteen claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

26,523/1913. IMPROVEMENTS IN AND RELATING TO STOWAGE, DECK TRANSPORT AND LAUNCHING OF SHIPS' BOATS. CAPT. W. P. THOMPSON, 44, PARKFIELD ROAD, AIGBURTH, LIVERPOOL, AND L. ADDISON AND S. J. CAREY.

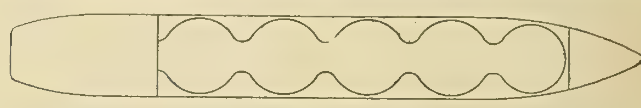
The invention relates to improvements in the stowage, deck transport and launching of ships' boats. Broadly, one primary feature of the invention consists in lowering boats down rails or other equivalent devices lying substantially in the plane of the ship's side, while supporting the boat bracket-wise on rails. The bogies are run along the deck rails so that their side wheels engage with a pivoted gangway. This is then



rotated to bring the boat with bogey into the overside position. The boat is then pulled by means of a davit or the like on to rails which extend down to the water. Where these rails are oblique or vertical it is preferable that they should run for some distance in a horizontal direction before turning downwards. After the boat has become waterborne and floated clear of bogey, the latter may be again raised, if necessary, either by way of the launching rail or a special return rail.

2,936/1915. IMPROVEMENTS IN OR RELATING TO SHIPS. J. J. BITTLESTONE, 11, LAURA STREET AND H. T. JOHNSON, BOTH IN SUNDERLAND.

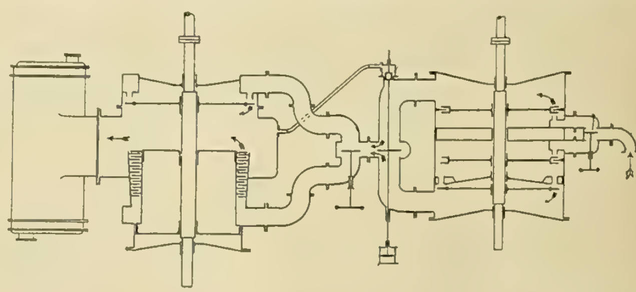
According to the invention the ship is provided with an inner skin at each side composed of continuous plating forming a series of alter-



nate bulges and recesses, the inner skin at one side of the vessel being independent of that at the other side throughout its length. The inner skin will tend to safeguard the vessel from flooding in the case of collision or damage.

5,879/1914. IMPROVEMENTS IN OR RELATING TO TURBINE INSTALLATIONS FOR MARINE PROPULSION. K. ALQUIST, 147, CLIFTON ROAD, RUGBY.

The object of the invention is to effect a saving in weight and cost of the machinery by running the turbines in series, thereby reducing the total number of bucket rings required for a certain efficiency, while at the same time preserving the independence in operation of each propeller shaft. The principle on which this object is obtained consists



broadly in so arranging the admission valves of the turbine units that each propeller may be run forward, stopped, or reversed without interrupting the flow through the turbines. The invention is illustrated in the drawing, which is a diagram of an application suitable for two propeller shafts. One shaft is driven by a high-pressure turbine dealing with about 50 percent of the total steam energy, approximately utilizing the steam from boiler pressure down to atmospheric pressure in the case of ordinary operating conditions, and the other shaft is driven by a low-pressure turbine utilizing the remaining steam energy down to condenser pressure. Both turbine units are provided with forward elements and reversing elements.

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Was this Accidental? Secretary of the Navy Daniels announced a few days ago that he wished to have representatives of different engineering societies in the United States appointed to consult with the Navy Department regarding the best methods of bringing the navy up to its highest efficiency. It seems strange that he should ask for representatives of almost every technical society in the United States except the one that can be of more real service to the navy than all of the others put together. We refer to the Society of Naval Architects and Marine Engineers. Was this an accidental oversight, or was it intentional because of the fear that some information might be given that he would not care to have brought before the Navy Department?

Bureau of Naval Inventions There can be no question as to the advisability and importance of utilizing in the most efficient manner the inventive ability of the people of the nation for the development and improvement of its navy. Each step in advance in the construction and operation of a naval fighting machine depends not only upon the practical knowledge of the men who are devoting their lives to naval service, but also to the countless inventions, discoveries and modifications made by scientists, engineers and mechanics working in fields not even remotely connected with naval construction. In the Navy Department, as previously conducted, limitations in authority and expenditures and Government "red tape" have undoubtedly delayed the adoption, or development, of useful inventions perfected by manufacturers for other purposes. There has also been a lack of means for encouraging men with inventive ability to make a special study of naval needs and requirements with a view to effecting improvements. If the Bureau of Naval Inventions, now in process of formation by the Secretary of the Navy, can be made to provide a practical method for stimulating the development of inventions especially for naval purposes, it will serve a useful purpose, but if the new Bureau is to act simply as an advisory committee to pass upon the practicability of new inventions for naval uses, there is little reason to believe that greater progress will be made than has already been accomplished by the experienced naval officers who direct the special work of the various bureaus in the Navy Department. No other class of men is more competent to judge the usefulness of new devices for naval purposes than the naval officers themselves, who direct the lines of development and policies of the various departments. On the other hand, if the Bureau of Naval Inventions proves to be a means of placing at the disposal of the Navy Department the most highly skilled and ablest men of the country for the actual work of solving special problems and adapting meritorious inventions to special lines of development for naval construction, it will open a field of vast possibilities. How effectively this can be accomplished remains to be seen. At all events, it is to be hoped that, by fostering the inventive resources of this country for its own needs, the Navy Department will no longer be forced to depend upon the initiative of foreign countries for necessary improvements.

The Eastland Disaster Until a thorough investigation has been made, the actual cause of the capsizing of the passenger steamer *Eastland* at her landing in the Chicago River, resulting in the loss of over eleven hundred lives, cannot be determined. It is evident, however, that negligence or incompetency on the part of some group of officials connected with the operation of the vessel was responsible for the appalling disaster. Both the Federal steamboat inspectors and the officers and crew of the vessel must face a most searching inquiry before the responsibility for the accident is fixed. During the twelve years that the *Eastland* has been in service she has been frequently used as an excursion boat, carrying large numbers of passengers under much the same circumstances as when the lamentable accident occurred. According to reports, she has been known among navigators on the lakes as a "cranky" boat with a lack of stability, which would indicate either that her design was faulty or that she was not being operated under the conditions of loading and ballasting for which she was designed. The reports also state that water ballast was necessary to maintain the stability of the vessel. If the water ballast tanks were not properly filled, there is every reason to believe that this would be the primary cause of the accident. If the vessel were improperly designed and unsea-

worthy, the sacrifice of 1,100 lives—not to mention other recent marine disasters—should be a sufficient warning to the public to create a demand for a steamboat inspection service that is capable of passing upon the designs of new ships, and that is invested with power by Congress to approve of such designs before the vessel is built. The Steamboat Inspection Service, as at present constituted, apparently has neither the power of approval of proposed designs nor the facilities for doing such work. A rule was promulgated by the Board of Supervising Inspectors four years ago requiring the owner of every new vessel over 100 gross tons, when making application for the first inspection of the vessel, to file with the local inspectors of the district where the vessel is to be inspected complete drawings of the hull of the vessel as a record for reference, so that the inspectors can become familiar with constructive details which otherwise could not be ascertained by the regular inspection after the vessel was built.

The Steamboat Inspection Service has given consideration to this very subject, but, so far, no steps have been taken to secure the necessary authority, or appropriations, for carrying it into effect. If such a plan is not feasible, some other way of obtaining the desired result should be devised. At least the Board of Supervising Inspectors should include one or more experienced shipbuilders or naval architects of recognized ability, competent to pass upon proposed designs and invested with authority to compel necessary alterations, so that every vessel certified to carry passengers will have at least the necessary stability and seaworthiness to insure the safety of its passengers under every condition of operation.

Growth of American Merchant Marine

The tonnage of vesels added to the American merchant marine during the fiscal year ended June 30, 1915, amounted to 744,618 tons, which is the largest annual addition to the American merchant fleet in the history of the United States. Other record years were 1908, when the total increase was 718,683 gross tons; 1907, with 596,708 gross tons, and 1855, when the increase was 586,102 gross tons.

In previous record years, however, the total addition consisted wholly of vessels built in the United States, whereas during the past year 528,907 tons, or 71 percent of the shipping added, consisted of foreign-built vessels admitted to American registry under the ship registry act of August 18, 1914. The number of merchant vessels actually built in the United States and officially numbered by the Bureau of Navigation during the past fiscal year was 1,226 of only 215,711 gross tons, as compared with 1,291 vessels of 311,578 gross tons for the fiscal year 1914.

The principal vessels built during the fiscal year 1915 were the colliers *Achilles* and *Ulysses* of 11,081 and 10,910 gross tons, respectively, built by the Maryland Steel Company for the Panama Canal trade. Other vessels over 5,000 gross tons included the oil tank steamer *John D. Rockefeller* of 8,374 gross tons, built by the Newport News Shipbuilding & Dry Dock Company for the Standard Oil Company; the 23-knot turbine passenger steamers *Great Northern* and *Northern Pacific,* of 8,255 gross tons each, built by the William Cramp & Sons' Ship & Engine Building Company for the Great Northern Pacific Steamship Company, and the *J. A. Moffett* of 6,395 gross tons and the *Lyman Stewart,* both oil tankers, built on the Pacific Coast. Only one large sailing vessel was built during the year, the *Georgia,* a schooner of 1,318 gross tons, while in all twenty-three steam vessels of over 1,000 tons each were built, aggregating 123,242 tons.

The losses to the merchant fleet for the past year have not all been reported as yet, but for the first nine months they numbered 1,062 vessels of 195,052 gross tons.

In June, the last month of the fiscal year (not previously reported in our columns), 176 vessels of various types, aggregating 16,767 gross tons, were built and officially numbered in the United States. Only six of these, of 7,943, gross tons, were steel steamships, the largest being the *Mariana,* of 3,063 gross tons, built by the Newport News Shipbuilding & Dry Dock Company for the New York & Porto Rico Steamship Company; the railway car ferry *Santa Clara,* built at Oakland, Cal., for the Central Pacific Railway Company, and the *International,* of 1,709 gross tons, built at Ecorse, Mich., for the Great Lakes Engineering Works. During the month three foreign-built vessels of 10,550 gross tons were admitted to American registry under the act of August 18, 1914, and up to July 17 the number of foreign-built ships added to the American merchant fleet had been increased to a total of 151 of 530,361 gross tons.

As the foregoing figures cover only the vessels completed or purchased during the last fiscal year, they do not indicate the present activity in the shipbuilding industry in the United States. The large volume of business that has filled the shipyards on the Atlantic Coast to full capacity, and which promises to keep them fully employed for several years to come, has all been booked since last December, and few vessels contracted for since that time have as yet been completed. The increased production in American shipyards, therefore, is not apparent in the official returns published by the Bureau of Navigation, although hereafter these reports will give a more accurate indication of the volume of this new business. In future also the tonnage added to the American merchant marine will not be influenced to such an extent by the number and tonnage of foreign-built vessels brought under the American flag in accordance with the special shipping act of August 18, 1914, as the largest steamship companies which could be directly benefited by this act have already taken advantage of the measure and transferred their vessels to the American fleet, and any additions to their fleets in the near future will undoubtedly consist of vessels built in American shipyards, as the conditions of the market at present are wholly favorable to American shipbuilders.

Large Orders for Oil Tankers Placed with American Shipbuilders

At no time in the history of shipbuilding in the United States has the production of oil tank steamships been greater than at present. In all, twenty-three oil tank steamships, of a total of 209,200 tons deadweight capacity, are under construction. The Standard Oil Company is building seven ships of this type of 89,200 tons deadweight; the Petroleum Transport Company, three vessels of 30,000 tons; the Anglo-Saxon Company, a British firm, three vessels of 25,200 tons; the Gulf Refining Company, two vessels of 19,300 tons; the Texas Oil Company, two vessels of 18,200 tons; the American Molasses Company, two vessels of 14,000 tons; the Union Oil Company, one vessel of 10,300 tons, and the Mexican Petroleum Company, three of 3,000 tons deadweight.

Of these vessels seven of 79,800 tons are being built by the New York Shipbuilding Company, Camden, N. J.; three of 41,200 tons, by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va.; four of 32,700 tons, by the Harlan & Hollingsworth Corporation, Wilmington, Del.; four of 32,200 tons by the Fore River Shipbuilding Corporation, Quincy, Mass.; one of 10,300 tons, by the Union Iron Works, San Francisco, and one of 10,000 tons, by William Cramp & Sons' Ship & Engine Building Company, Philadelphia, Pa.

Of the seven oil tankers building at the New York Shipbuilding Company's plant, four are for the Standard Oil Company of New York; two for the Gulf Refining Company, and one for the Petroleum Transport Company. All of the oil tankers ordered from the Newport News Shipbuilding & Dry Dock Company are for the Standard Oil Company of New Jersey. The order for three oil tankers for British owners was placed with the Harlan & Hollingsworth Corporation, and this company also is building one oil tanker for the Petroleum Transport Company. Two of the tank steamers under construction at the Fore River shipyard are for the Texas Company, the other two being for the American Molasses Company, while the orders for one large oil tanker each, placed with the Union Iron Works and the Cramp shipyard, came from the Union Oil Company and the Petroleum Transport Company, respectively.

The large orders for oil tank steamships placed in American shipyards are due partly to conditions brought about by the European war and partly to the natural expansion of the oil companies. With the oil fields in the northern part of France inoperative on account of the war, and transportation facilities from other oil-producing districts impaired, the supply of oil in such neutral countries as Norway has been seriously curtailed, causing advances in the price of fuel oil to as much as $24 (£5) per ton. Under such conditions the available supply of fuel oil in large quantities is limited almost wholly to the American oil fields, consequently the demand for tonnage for the transportation of American oil has caused the immediate expansion of the marine transportation facilities of these companies.

In the case of the Standard Oil Company of New York, a $15,000,000 (£3,080,000) subsidiary company has been incorporated known as the Standard Transportation Company, which has taken over the fleet of twenty-five vessels owned by the Standard Oil Company of New York, including six ocean tankers and half a dozen ocean-going tugs. As can be seen from the foregoing figures, four large tank steamers will be added to this fleet within a year, and two others will be delivered during the following year, making one of the largest oil-carrying fleets in the world.

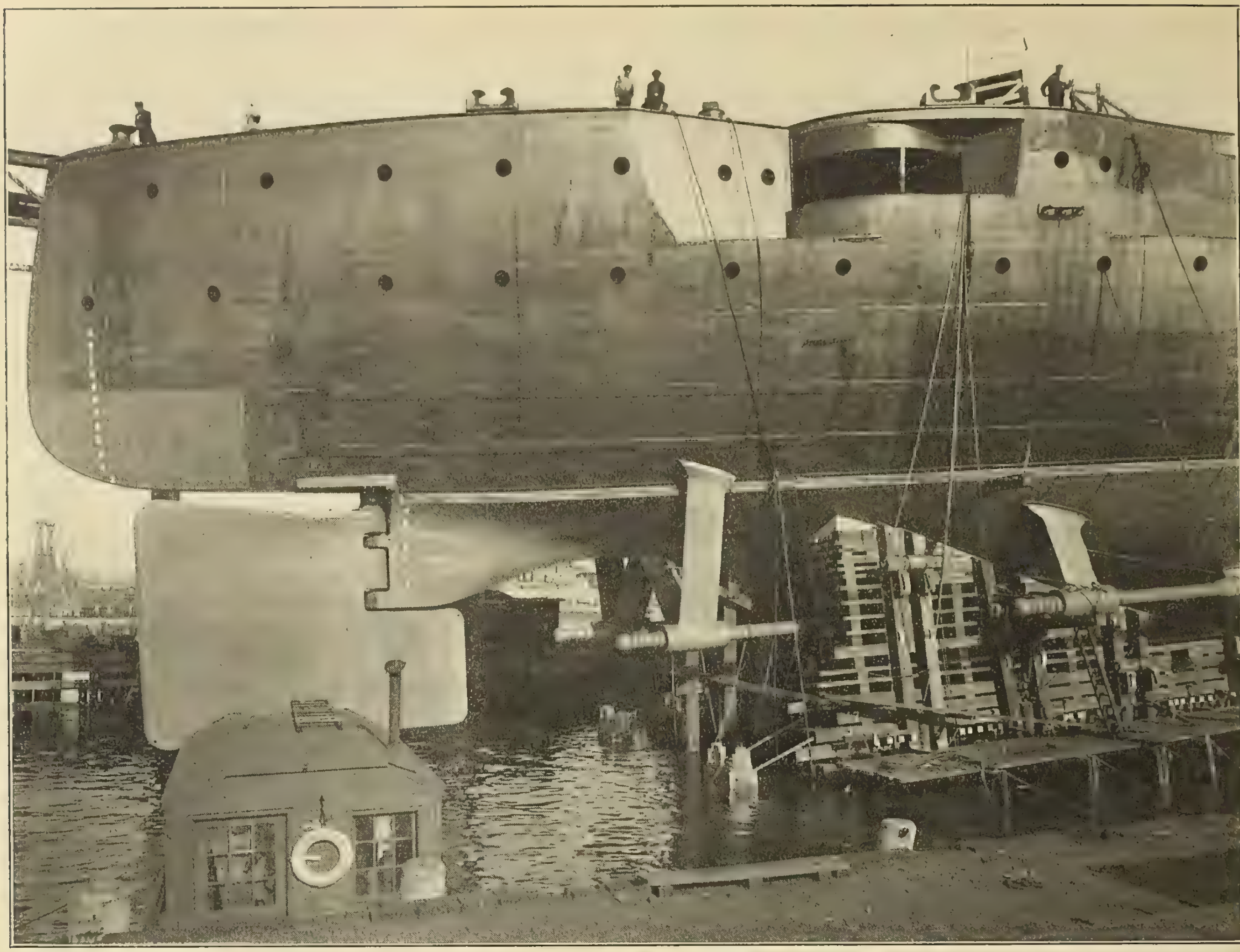
Losses of Merchant Shipping

Approximate figures recently published show that during the first ten months of the European war 511 merchant vessels with a total tonnage of 915,457, representing about 2 percent of the total shipping of the world, were lost. At the outbreak of the war England's merchant marine amounted to 20,431,000 tons and Germany's to 5,082,000 tons. During the first ten months of the war England lost 609,934 tons of shipping, Germany 102,000 tons, Norway 47,000 tons, and France 42,000 tons.

The actual destruction of 2 percent of the world's merchant tonnage by the war, however, does not represent the most important effect of the war on merchant shipping during this period. Immediately after the outbreak of the war the construction of merchant vessels in the belligerent nations, which hitherto have been the largest producers of merchant shipping in the world, was virtually brought to a standstill. Practically all of the available resources for building ships in these countries were immediately directed to naval work, and, at the same time, the exports of manufactured products and staples from these countries rapidly decreased, so that the demand for new tonnage was correspondingly greatly diminished.

Taking the case of Great Britain, nearly 2,000,000 tons of merchant shipping were under construction at the end of 1913. At the end of 1914 there was a decrease of about 329,000 tons building. Again, at the end of the March quarter in 1915 there was a further decrease of over 40,000 tons, while at the end of the June quarter in this year there was a still further decrease of nearly 81,000 tons, making a total decrease of 25 percent in the tonnage of merchant vessels building as compared with the work in hand at the beginning of last year. As far as the British foreign trade is concerned, for the first five months of the present year the exports have shown a decrease of 30.24 and the re-exports a decrease of 16.92 percent as compared with the same period in 1914. Difficulties have also been experienced by British shipbuilders in obtaining capital, labor and materials, causing an abnormal increase in the price of merchant vessels and uncertainty as to their time of delivery.

Under these conditions, the combined effect of decreased production and lessened demand for tonnage has been far more disastrous to the shipping industry in the countries at war than the actual destruction of a small percentage of the world's shipping. In neutral countries, however, the reverse has been the case and both the shipbuilding and shipping industries have increased to a marked degree.



Launching of the Battleship Arizona

Construction of the Launching Ways, Fore Poppet and Cradle—Method of Release

BY G. H. BARBER

On June 19, at 1.09 P. M., the superdreadnought *Arizona* was launched into the East River from the New York Navy Yard in Brooklyn. The launching took place at the time set and was entirely successful throughout, reflecting great credit on those responsible for the working out of the details for the transference of the great mass of potential fighting material from the keel blocks and shores to the water.

The principal dimensions of the vessel are as follows: Length overall, 608 feet; length on waterline, 600 feet; breadth, extreme, 97 feet ½ inch; mean trial draft, 28 feet 6 inches; mean trial displacement, 31,400 tons; designed speed, 21 knots; motive power, Parsons turbines.

The launching weight, exclusive of the cradle and ways, was about 12,800 tons. This includes dunnage and interior shoring. The total weight on the grease amounted to about 13,350 tons. The corresponding weight of the sister ship *Pennsylvania,* launched in March at Newport News, Va., was about 14,100 tons.

The sliding ways and cradle were 70 inches wide and had an effective length of 505 feet. The initial pressure per square foot on the grease was about 2.27 tons, which is well within the maximum allowable for the yard building slip.

Special care was taken to prevent local straining and buckling of the ship, in wake of the thrust from the cradle, by the fitting of interior shoring. This shoring was designed to distribute the pressure into bulkheads, longitudinals and floors, and extended nearly throughout the extent of the cradle. In wake of the fore poppet the structure was most efficiently stiffened against crushing during pivoting by the fitting of 14-inch by 14-inch yellow pine cross braces on each frame and half frame. These braces set into wooden shoes shaped to fit against the inner bottom, the inner bottom being well shored against the outer shell. No signs of strains or deformations were found after the launching.

The fore poppet was of the well-known "trunnion" type, which had proved very satisfactory in launching the U. S. S. *New York.* The sliding faces of the trunnion had a radius of 50 feet and a fore and aft length of about 23 feet. One of the features of the fore poppet was the means taken to carry the location of same as far forward as possible. This was done in order to reduce the pivot-

ing pressure and gain additional length of sliding ways for reducing the unit pressure on the ways. As the ship was not wide enough, at the point selected, for the fore poppet, to afford effective bearing for the cradle, three medium steel plate slings extending under the ship from side to side and having suitable brackets attached, were built so as to virtually form a false shell far enough from the centerline of the ship to give the required effective bearing area. Through the tops of the sling plates steel wire rope lashings were passed and made fast to clips bolted high up on the shell. These lashings were later used for removing the entire fore poppet by slacking away and carrying them forward of the bow, and so allowing the fore poppet to fall clear of the ship.

The space between the shell and the slings was filled with a concrete mixture of 1 : 3 : 5, a fine meshed stone being used. The concrete was poured some three weeks

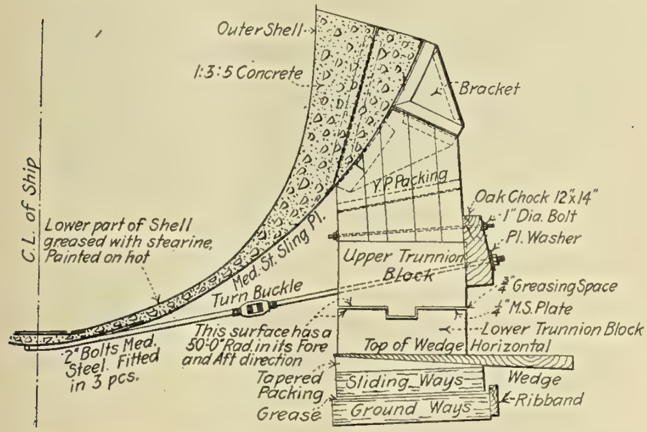


Fig. 2.—Section Through Fore Poppet, Starboard Side Looking Forward

previous to the launching. The effect of this arrangement (see Fig. 2) was, of course, to give the ship temporary increased width locally as required. The under portion of the shell in wake of the concrete was greased with stearine, painted on hot, and the concrete was tied back to the slings by perforated flanged plates bolted to the slings to prevent failure or shifting of the concrete under the pivoting pressure.

The assumed pivoting pressure for which these slings were designed was 2,700 tons, while the actual pivoting

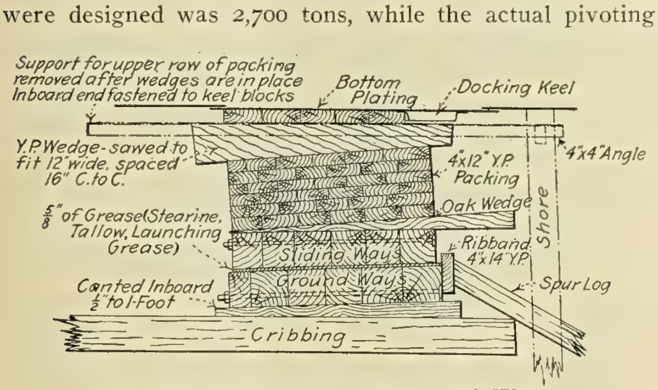


Fig. 3.—Section Showing Cradle and Ways

pressure was slightly less, being about 2,650 tons. The trunnions functioned properly, rotating through an arc of about 27 inches.

The cradle was made up for the most part of 4-inch by 12-inch yellow pine planking, fitted longitudinally, as shown in Fig. 3. The upper row of packing was fitted to the shell and held in place by 4-inch by 4-inch angle iron beams spaced at intervals. After the lower packing had been placed on the driving wedges the upper wedges were cut to suit and driven home and the angle irons removed. At the forward and after ends 12-inch by 12-inch yellow pine timber fitted to the shell was used. The character of the after cradle is shown in the photograph

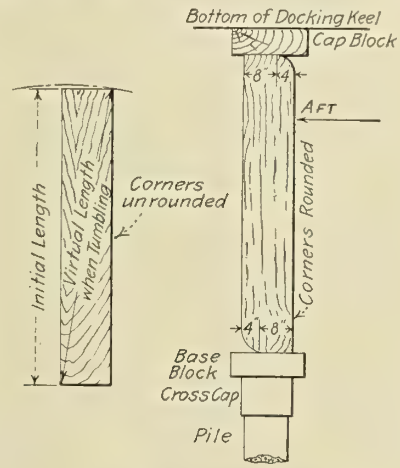


Fig. 4.—Tumbling Shores

(Fig. 1). The cradle was held in place by nine steel wire rope frappings, two forward and seven aft.

The manner of supporting the ship up to the time of releasing is worthy of note. About a month prior to the launching some fifty alternate keel blocks were removed, working from forward one at a time and sand blocks substituted therefor. The sand block is made up of a box composed of channels, bolted together at the corners and closed top and bottom by fitted oak pieces. There is a space of about two inches between the inner faces of the two oak pieces, which is filled with dry sand. To remove this type of block the corners need only be unbolted to

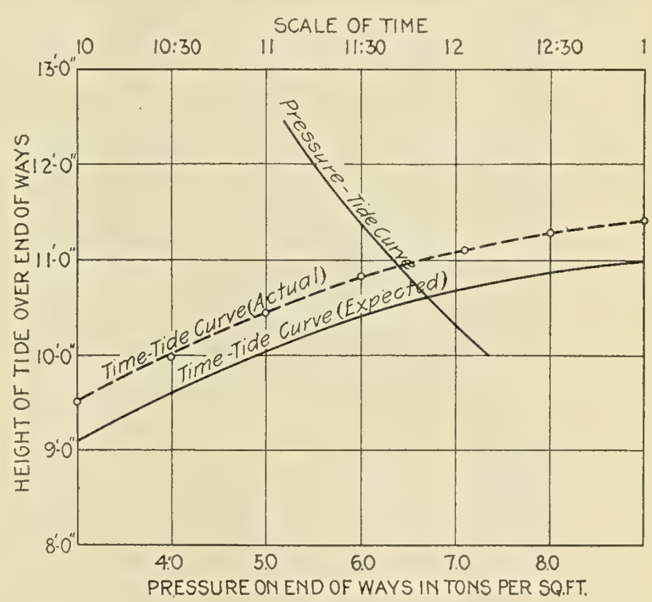


Fig. 5.—Tide and Pressure Curves

allow the sand to flow, when the whole block with supports may be quickly removed.

All keel blocks aft of the point where the low water level crossed the lower stringers were removed gradually, as occasion offered, some six weeks before the launch, and tumbling shores fitted in place thereof. These shores were rounded off at their top forward and bottom after ends, thus allowing them to tumble when the ship started to

move down the ways. These after-tumbling shores were roped to the packing to be carried out with the ship, thus preventing their piling up and fouling the bottom of the ship or the lashings of the fore poppet. Also under the outer docking keels the regular shores were converted into tumbling shores under alternate frames.

After all the side shores and cribs had been removed the ship was still very well supportetd on the tumbling shores and sand blocks. The fifty sand blocks were removed in about ten minutes just before releasing. By the use of the sand blocks and tumbling shores the hard work and uncertainty attendant upon removing the last keel blocks and shores were avoided and the ship was supported until the last possible moment before it started down the ways.

When tumbling shores are used particular attention must be paid to the amount of round given to the top and bottom of the shore. It is apparent that if no round were given to the corners the virtual length of the shore in tumbling would become that of the diagonal. This would result in either the holding of the ship or in local deflections of the structure, if the ship should push by. Experience with these shores, which were also used on the *New York* launching, shows that they operate successfully when rounded off about one-third the diameter or face width at top and bottom.

Hydraulic Releasing Trigger

The releasing device used was the hydraulicly operated trigger, there being one fitted for each way. They were so connected as to be operated together by the turning of a valve which released the fluid contained in the hydraulic cylinders. The fluid was a 30 percent mixture of glycerine and water. The trigger consisted of a bell crank of special forged steel, the upper end bearing against the sliding ways and the lower end bearing against a piston sliding in a cylinder fastened to the ground ways. The trigger turned about a pin through its central point, the pin seating in a casting attached to the ground ways.

The triggers were located in pits beneath the ways at about frame No. 69. A cross passage gave access from one pit to the other. All the operations were directed from the starboard pit, which was connected by voice tubes with stations at the port and starboard sides on the ship and at the forward end of the ways where the starting rams were located. The starting rams had a capacity of 250 tons for each side.

A dog shore was fitted on each side aft as a precaution against a premature release of the vessel. This shore was made of 14-inch by 16-inch oak timber, iron shod at each end. The forward end bore against a chock, which was bolted to the sliding ways, while the after end was rounded and turned in a shaped log bolted through to the cross caps on the piling. The shores had a fore and aft slope of 1½ inches to the foot. The dog shores were not called into use and were dropped clear just prior to the release of the ship.

One of the interesting minor details was the plan showing curves for height of water over the end of ways plotted on a time base, and also the maximum bottom pressures for varying heights of tide. The curve of expected tide, the highest point of which had been used in making the launching calculations, was plotted from 10 A. M. to 1 P. M. The actual height of tide was obtained on the 19th and plotted at one-half hour intervals, thus indicating whether the actual tide would be under or over the expected tide. The maximum bottom pressures or thrust from the end of the ways in tons per square foot was plotted on the height of tide for values between a 1-foot higher and a 1-foot lower tide. The actual maximum bottom pressure at the moment of release could then be seen at a glance. This maximum pressure for the *Arizona* was about 5.8 tons per square foot.

The removal of the 500 odd tons of cradle was provided for before launching. Wire rope lashings were passed around the cradle and carried up to the main deck. Rider logs were fitted above the cradle at intervals and carried outboard as far as the docking keels. The under side of each log was painted with stearine. A wood chock fitted to the shell and connected to the docking keel by a plate bracket carried the outboard end of the log and kept it lower than the docking keel, so that no damage could be done to the docking keel in pulling out the cradle and so that the cradle would slide by without jamming. Likewise in wake of the bilge keels tapered chocks were fitted so as to allow the cradle to slide freely by and without damage to this keel.

The usual observations for hogging and sagging by means of a transit and sighting batteries were made; no appreciable hog or sag was found. The velocity was obtained by four pairs of observers working independently. The time when certain distance marks, painted on the ship at the level of the armor shelf, passed the observers was noted on paper strips pasted on the dials of stop watches, the watches being started at the instant the vessel began to move. The maximum observed velocity was 21 feet per second, the maximum acceleration was 1.4, and the minimum coefficient of friction derived from the acceleration was .01.

The vessel was afloat in about 42 seconds. It ran to midstream and about half the distance to Williamsburg bridge. It was then taken in tow and brought to Pier D, where the vessel is now being completed.

The Superiority of Tungsten Lamps for Lighting Ships*

BY L. C. PORTER †

The use of tungsten lamps aboard ships offers several exceptional advantages. Space and weight are of considerable moment on board modern high-speed passenger vessels. Reliability is also of great importance. Repairs when necessary must frequently be made at short notice and without most of the facilities obtainable ashore. The use of tungsten-filament lamps, consuming approximately 1.10 watts per candle-power as against 3.10 to 3.50 by carbon-filament lamps, means smaller and lighter generating apparatus, lighter wiring throughout the ship, less coal storage space necessary, etc.

It frequently happens, when changing over the lighting equipment of a ship from carbon lamps to tungsten lamps, that one generator may be shut down and held in reserve. Smaller and lighter storage batteries for emergency use are required for tungsten lamps than for carbon lamps.

The lighting problems of passenger vessels may be divided into five main parts: (1) social halls, (2) dining rooms, (3) smoking rooms, (4) staterooms, and (5) passageways. In addition to these there are certain parts of the ship where a relatively small number of lamps are used, such as engine rooms, bar rooms, barber shops, boiler rooms, freight holds, etc.

Investigation shows that there are two general types of steamers in the coastwise, river, and lake class, those making comparatively short runs and those making trips of several days. On the former, the social halls consist of a large well, or opening, running up one or two decks

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* Extract from an article on The Lighting of Ships in *The General Electric Review*.

† Edison Lamp Works, Harrison, N. J.

above the main deck. This class of social hall is well illustrated by the photograph taken on the Fall River Line steamer *Priscilla*, Fig. 1. On ships making long trips, the social halls are smaller and generally but one deck high. Also they are usually not lighted quite as elaborately. Ceiling lamps are found frequently supplemented by lamps in wall brackets.

Illumination measurements, taken on a large number of ships lighted with carbon lamps, showed an average foot-candle intensity, on a plane three feet above the floor, of 1.1 on long trip ships, and 1.5 for the short run class.

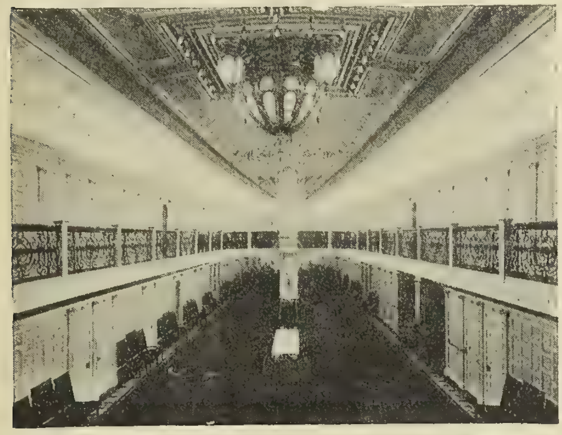


Fig. 1.—Saloon of Steamship *Priscilla* of the Fall River Line

An interesting demonstration of the great improvement obtained by substituting tungsten-filament lamps for carbon lamps was made in the social hall of a boat of the short run type. Thirty-eight 60-watt, all-frosted carbon lamps, giving an average intensity of 1.4 foot-candles for an energy consumption of 2.3 watts per square foot, were replaced by thirty-eight 25-watt, all-frosted tungsten lamps. These lamps gave 2.7 foot-candles illumination with an energy expenditure of 1.0 watt per square foot.

Dining rooms are very similar on each class of ship. Round-ball enclosing globes located on the ceilings were considerably used. On one ship the 16 candle-power clear carbon lamps in enclosing globes were replaced lamp for lamp by 25-watt clear tungsten lamps. The carbon lamps gave 1.1 foot-candles for 1.5 watts per square foot, while the tungsten lamps in the same fixtures gave 1.4 foot-candles for 0.6 watt per square foot. Fig. 2 shows a section of the dining room of the Hudson River Line steamer *Adirondack*.

Fig. 2.—Dining-room of the *Adirondack* of the Hudson Navigation Company

Smoking rooms have a fairly high ceiling on the short run ships and a low one on the long trip class. Fig. 3 shows the arrangement employed in the smoking room of a steamship on the line of the Old Dominion Steamship Company, which illustrates the latter type of lighting. All-frosted lamps located overhead are usually used. The average illumination 3 feet above the floor was found to be 1.25 foot-candles for an energy consumption of 2.09 watts per square foot.

Fig. 3.—Smoking Room in Old Dominion Line Steamer

In passageways a low illumination is all that is needed. This is frequently obtained by small lamps located on the ceiling spaced about 10 feet apart. The average intensity is about 0.8 foot-candle.

The staterooms are generally rather poorly lighted, having but one lamp located in the center of the ceiling. Great improvement is obtained by locating this lamp over the center and one foot out from the mirror, this allowing comfortable shaving, etc., and at the same time giving good general illumination in the room. A stateroom on the Savannah Line steamer *City of Montgomery*, having a lamp at the center of the ceiling and a portable lamp near the berths, is shown in Fig. 4.

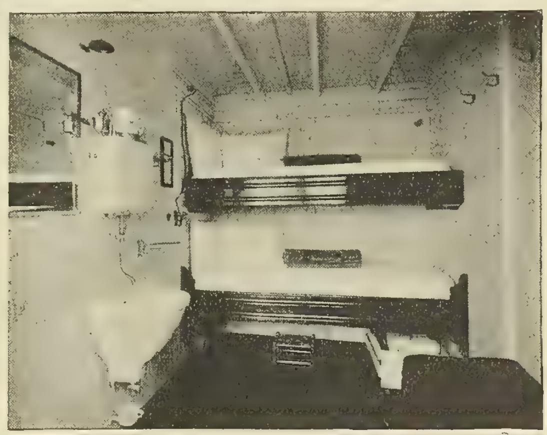


Fig. 4.—Stateroom of the *City of Montgomery*, Savannah Line

The lighting of ferries was found to be very uniform. In practically all cases the cabins were lighted by carbon lamps, in one- or two-light fixtures located on the walls over the seats. In a few cases round-ball, all-frosted lamps were in use. On the New York municipal ferryboat *Richmond*, one hundred 60-watt high-efficiency carbon lamps were replaced lamp for lamp by 40-watt medium efficiency tungsten lamps. The former gave an average of 1.13 foot-candles, on a plane 3 feet above the floor, with an energy consumption of 1.96 watts per square

foot, while the latter gave 3.36 foot-candles for 1.50 watts per square foot. Figs. 5 and 6 show this cabin before and after the change.

In many instances it is impracticable to change the existing wiring of a ship and, for this reason, the recommendations for a new ship would vary considerably from those

Fig. 5.—New York City Ferryboat *Richmond* Lighted with 60-Watt Carbon Lamps

for a ship at present in commission. When the wiring is already installed, the expense involved in changing the outlets may more than offset the advantages to be secured by such a rearrangement of units as will provide the most economical and effective operation. On the ships which

Fig. 6.—The *Richmond* Lighted With 40-Watt Mazda Lamps

have been studied it was usually apparent that a better economy, and often a more effective illuminating effect could be produced by the use of a smaller number of tungsten-filament lamps of higher candle-power, but in every case it was considered unwise to change the existing outlets. However, advantage has been taken of the higher efficiency of the tungsten-filament lamp to increase the intensity and, at the same time, reduce the lighting cost by substituting, lamp for lamp, 25- and 40-watt tungsten-filament lamps for the high wattage carbons. In some instances it was possible to also improve the diffusion by substituting frosted bulbs for clear ones.

Rapid Coal Handling Plant on the Lakes

A car dumping plant, recently erected on the Cincinnati, Hamilton & Dayton railroad dock at Toledo, Ohio, by the Wellman-Seaver-Morgan Company, Cleveland, Ohio, has established the remarkable record of unloading 340 cars of coal into lake steamships in 10 hours, making an average of 34 cars per hour. The time given includes that taken for the shifting of the boats, in order to dump the coal into different hatches. The best record for one hour was 49 cars unloaded.

The dumper is similar in design to those recently erected by the Wellman-Seaver-Morgan Company in Cleveland and Sandusky for the Pennsylvania lines, the most important change being in the use of a disappearing haulage car. This cable-propelled haulage car, instead of

New Car Dumping Plant on the Cincinnati, Hamilton & Dayton Railroad Docks at Toledo

being lowered into a pit under the inclined track, goes down into a trough under the track, as shown in the illustration, the track being raised and lowered at each end of the trough by a swinging gate. The haulage car, after pushing a loaded car on to the machine, is run back and down through the trough, coming up behind the next loaded car that has been run down on the track in front of the machine.

The use of the disappearing haulage car saves a number of employees, as compared with the former pit arrangement. With this plant the cradle that carries the car up to the pan and spout into which the fuel is dumped by turning the car over is elevated 30 feet above the water, or 5 feet higher than the elevation in most plants of this type.

This unloader has a capacity for handling cars of 100 tons capacity, the largest made.

Naval Architects' Annual Meeting.—The twenty-third general meeting of the Society of Naval Architects and Marine Engineers will be held in New York City on Thursday and Friday, November 18 and 19.

Reduction Gears on the Pennsylvania

Cruising Turbines Fitted with Westinghouse Hydraulic Floating Frame Reducing Gears, Designed to Transmit 1,600 Horsepower

The general features of the machinery for the United States battleship *Pennsylvania* have been briefly discussed in the engineering press. Now that the cruising gears have been built, some additional information regarding their construction will be of more than passing interest.

The *Pennsylvania* has four shafts and propellers. Each inboard shaft is driven by a high-pressure turbine placed in the forward engine room and has an independent backing turbine located in an engine room immediately aft of the forward one. Each outboard shaft is connected to two cruising turbines, located in the forward engine room, and also to the main low-pressure turbine, with its ahead and astern elements placed in the after engine room.

At cruising speeds steam from one cruising turbine passes to the other cruising turbine, then to the main high-pressure turbine driving the inboard shaft, and finally to the main low-pressure turbine on the outboard shaft. At high speed both of the cruising turbines are disengaged and the steam enters the main high-pressure turbine and passes directly to the main low-pressure turbine.

This arrangement of propelling machinery, while adding to the number of units, has a distinct advantage in steam consumption over the earlier systems, in which the main turbines are used for cruising purposes. As about 90 percent of the total voyages of a battleship are made at cruising speed, the importance of obtaining the highest possible economy at this speed is apparent.

In order to get this better economy the two high-speed cruising turbines are connected to the outboard propeller through the medium of a two-pinion Westinghouse hydraulic floating frame reduction gear. The details of these gears are clearly shown by the end elevation, Fig. 2; the plan view, Fig. 3, and the side elevation, Fig. 4. The clutch coupling on the main gear shaft serves to disconnect the cruising turbines when the vessel is traveling at full speed.

The general construction is the same as used on all high-speed, high-power gears built by the Westinghouse Company, the distinctive feature of these gears being the use of the floating frame, which insures uniform tooth pressures under all load conditions. The practical value of the floating frame has been thoroughly demonstrated, some of the first gears built having been in continuous service over four years. The teeth of these gears, it is

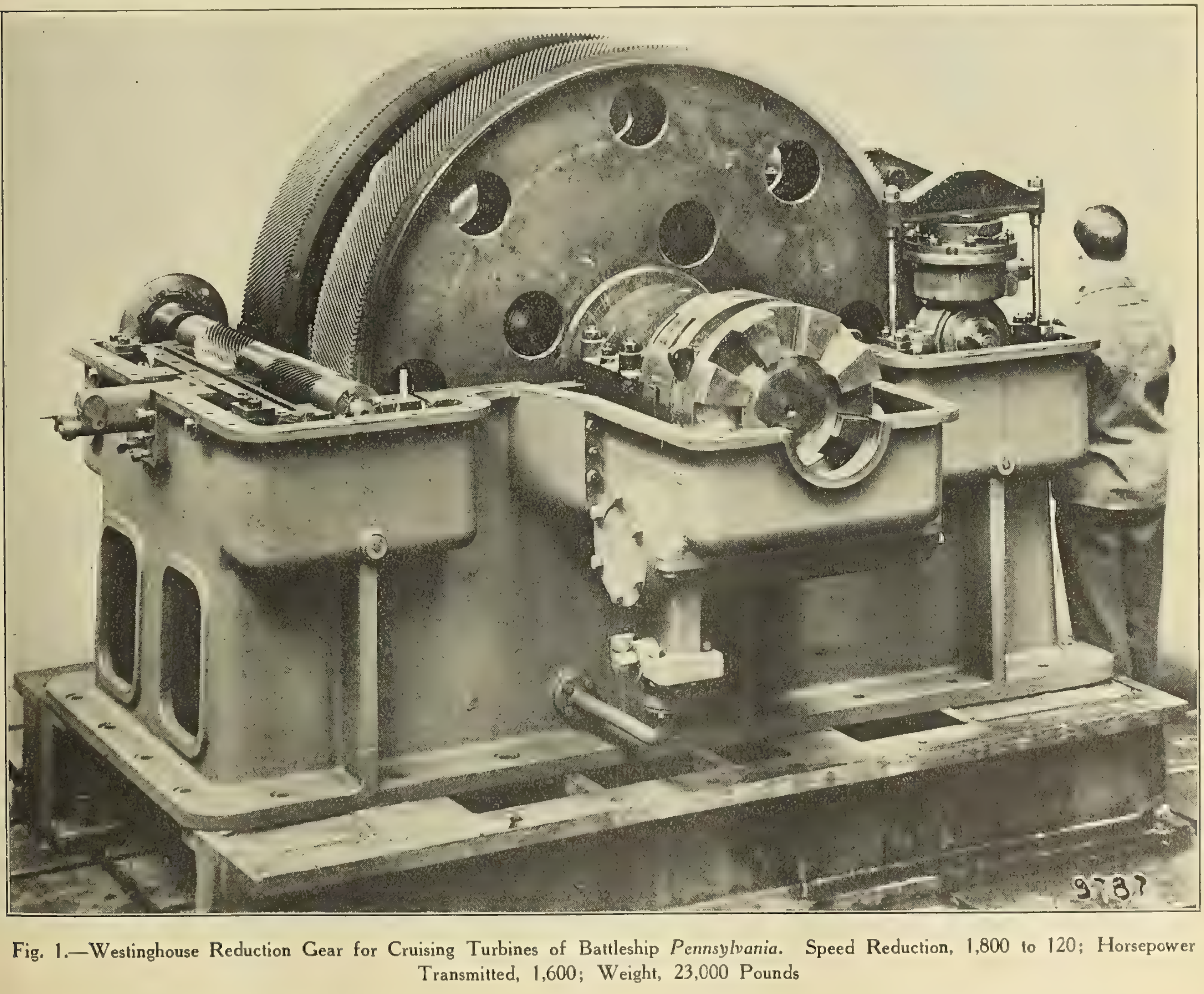


Fig. 1.—Westinghouse Reduction Gear for Cruising Turbines of Battleship *Pennsylvania*. Speed Reduction, 1,800 to 120; Horsepower Transmitted, 1,600; Weight, 23,000 Pounds

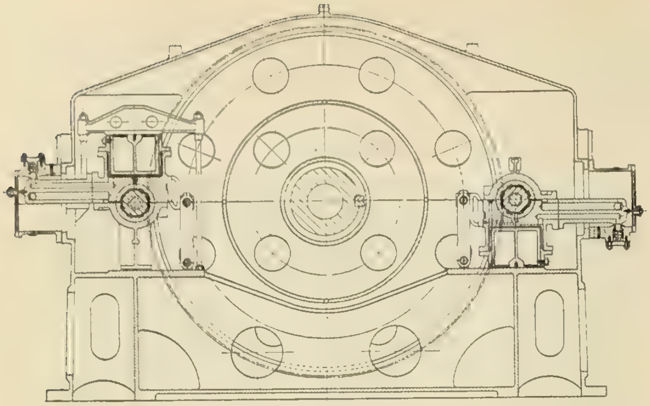


Fig. 2.—End Elevation

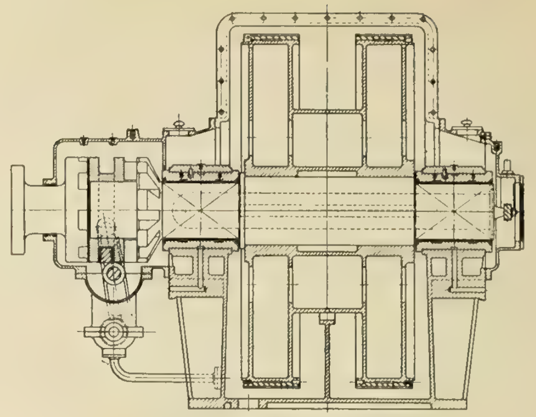


Fig. 4.—Side Elevation

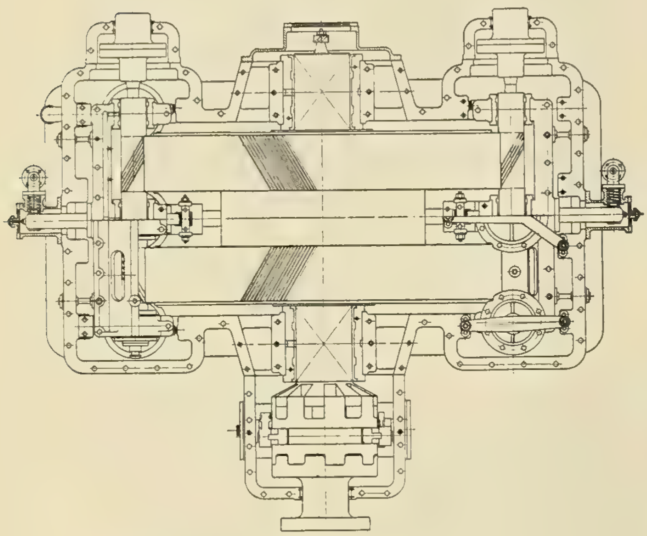


Fig. 3.—Plan

claimed, show no wear that can be detected and the uniformity of the pressure distribution is very marked, as the whole length of the gear tooth face is well polished.

An additional advantage gained by using the floating frame is the ease with which the horsepower transmitted may be determined. Experience has shown that in a high-speed bearing, such as employed here, the oil pressure developed by the bearing is directly proportional to the power transmitted. It is only necessary, therefore, to connect the oil pipes from the floating frame to a pressure gage and obtain the speed by means of a suitable tachometer. Obviously, both of these instruments may be of the recording type, so a continuous record of the shaft horsepower developed may be obtained.

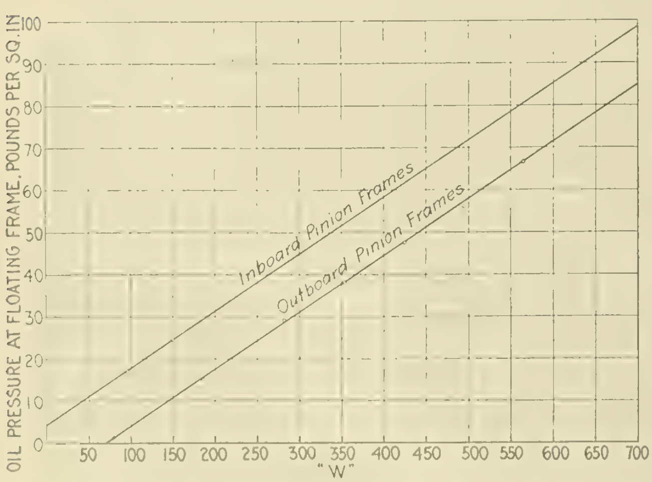


Fig. 5.—Floating Frame Calibration Curves U.S.S. *Pennsylvania* Cruising Reduction Gears. B.H.P.$=W\times$R.P.M. of Gear Wheel $\cdot$0.0118

Calibration curves for these particular gears are shown by Fig. 5. The difference in oil pressures on the inboard and outboard frames is due to the fact that in one case the floating frame is above and in the other below the pinion bearings. Supposing the oil pressure on the inboard side is sixty pounds and on the outboard side forty pounds; from the calibration curves it will be seen that the corresponding values of W are 415 and 367, respectively. Multiplying the sum of these, or 782 by the revolutions per minute of gear wheel and by the constant 0.0118, the shaft horsepower is readily obtained.

The general construction of these gears and their size are clearly shown by Fig. 1. Each gear is designed to transmit sixteen hundred shaft horsepower, with a speed reduction from eighteen hundred to one hundred and twenty revolutions per minute. The weight of each gear exclusive of the clutch is twenty-three thousand pounds.

Notes on the Conversion of Cargo Vessels into Bulk Oil Carriers—V

BY F. K. RUPRECHT *

There are great advantages in using single clips double riveted instead of double clips on all oiltight work. In the case of the stringer brackets the clips can be riveted and rivets calked to the bulkheads and the horizontal flanges punched. Then these holes can be templated to the brackets, and the stringers and brackets riveted up on skids and then lifted into place in one piece. The clips for the brackets at the centerline and at the webs can be riveted and calked to the bulkhead plates before they are placed in the ship. Single clips, of course, need not be calked to bulkheads, but only the rivet points, whereas double clips must be calked as well as the rivets.

Bulkheads in the after part of the ship in the way of the shaft tunnel will be the same as the forward ones, except that the angles will be carried around the tunnel. The vertical stiffener closest to the centerline bulkhead will have to be cut and bracketed to the tunnel. The

* Associate Member Society of Naval Architects and Marine Engineers.

bracket from the lowest horizontal stiffener will in some cases have to be riveted to the tunnel by offsetting it.

In the construction of all bulkheads no stop waters, packing or red lead are to be used. Metal to metal contact will be obtained throughout, and countersunk plug-headed rivets with full points will be found the best to use.

The calking side of the centerline bulkhead should be reversed in each tank, and the transverse bulkheads should be calked on the forward side in one case and on the after side in the next. This simplifies testing to a great extent and makes the final calking a less expensive job.

Since it will be necessary to dry dock the boat while fitting the lower strakes of the bulkhead plating and other strakes of bulkhead plating. All butts and laps will be double riveted. The connection to the upper deck will be by a continuous angle, double zigzag riveted, and the connection to the tank deck may be by an angle of the same size or a flanged plate may be substituted.

Web stiffeners will be fitted to the expansion trunk bulkheads in line with those on the centerline bulkhead. These webs will be clipped to the shelf of plating at the main deck and riveted to the upper deck beams at their upper edge. If the shelf of plating has not been left at the main deck, the web plates will have to be carried down and riveted to the strong beams. The connection of the webs to the bulkheads will be through the ordinary stiffener with a double-riveted lap, and no special construction will be required. The web plate may be flanged at the outer

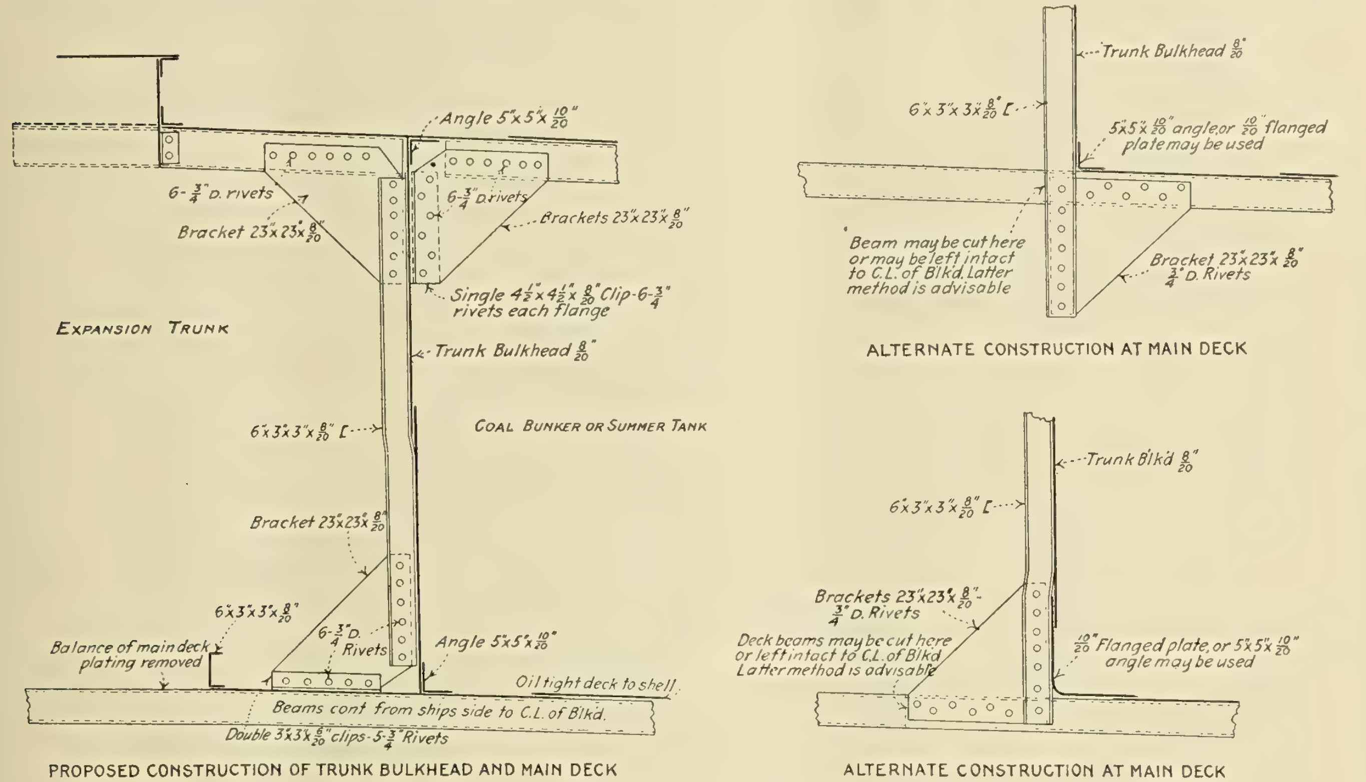


Fig. 16

riveting to shell, it will pay to plan the entire job very carefully so as to cut down the time spent in dry dock as much as possible.

Expansion Trunks

A few of the points in the construction of the expansion trunk bulkheads have been considered under the heading of "Decks."

The weight of plating and size of stiffeners will be taken from the classification rules. The vertical stiffeners will be placed on the inside of the bulkheads and will be bracketed at the bottom to the shelf of plating at the tank deck and at the top to the upper deck. The expansion trunk bulkheads will be continuous throughout the tanks and cofferdams, but they will be oiltight in the tanks only and in the cofferdams will have large access openings cut in them. The upper deck beams will be cut at the trunks and bracketed on both sides. The brackets will be clipped by double clips to the bulkhead in the 'tween decks, or single clips with double riveting may be substituted, and riveted to the stiffeners on the oil side (Fig. 16). The plating will usually be erected in two strakes running horizontally, and will be about the same thickness as the lower edge or may be fitted with a face angle, but flanging will be found the best.

The construction of the trunk bulkheads will be the same as elsewhere in the cofferdams, except that large openings must be arranged for access, drainage and ventilation.

The trunk bulkheads will be connected to the engine and boiler room casing to provide for a continuation of longitudinal strength. It is seldom, however, that these two bulkheads will be in line, and the methods of joining them are two. In the first the trunk bulkheads are carried at an angle from the cofferdam to casing, to which it is connected by double or triple riveted lap. In the second method the trunk bulkheads are carried straight through and are connected to the engine room and boiler room bulkheads by a large angle, and then brackets carried from these bulkheads to the casing. The former method is the less expensive and the strongest. In this case the trunk bulkheads will not be straight through the cofferdam aft of the engine room, but this is not detrimental. When trunk bulkheads pass through the cross bunker an opening must be cut in them for trimming the coal.

If summer tanks are provided, the expansion for these will consist of a standpipe the same size as the oiltight hatch on the weather deck. In the case of a shelter deck vessel this trunk will extend through the shelter 'tween decks, but in the case of a two-deck vessel it will terminate about three feet above the upper deck—that is, the expansion trunk will consist of a high coaming hatch. The connection at the upper deck in both cases will be by a large, single angle, double zigzag riveted with furnaced corners and a similar one will be fitted at the shelter deck. In the shelter deck vessel the plating forming the trunk may be arranged in vertical or horizontal strakes, but in the case of the two-deck vessel one horizontal strake is all that is necessary. This plating will be about the same weight as the expansion bulkheads, and in the shelter deck ship small vertical angles must be fitted to stiffen the plating.

Shaft Tunnel

With the machinery amidships, an oiltight tunnel must be fitted for the shaft. With the engines in the stern of the vessel, of course, no tunnel is needed. No access from engine room to tunnel will be allowed, and all access will be through oiltight trunks from the uppermost deck.

The entire old tunnel will be removed and an oiltight one substituted. This new tunnel may be circular or oval in section or may have a circular top with straight sides. The circular tunnel is, in most cases, desirable owing to its strength to resist external pressure, and it should never be under six feet in diameter. The plating is best arranged in five strakes with heavy angle stiffeners on the outside. These will be in line with stiffeners on the centerline bulkhead and will be cut and bracketed to the bulkhead or stiffeners on both sides. The angles of the transverse bulkheads will be carried around the tunnel. The centerline bulkhead will be built in two sections, one under the tunnel and one above the tunnel to the tank deck level. The centerline bulkhead nor the tunnel are on the exact centerline of the ship, and therefore the bulkhead angles top and bottom will not lie on a diameter. The vertical stiffeners on the centerline bulkhead will be cut at the top of the tunnel clear of the longitudinal angles. No vertical stiffeners need be fitted under the tunnel, but flanged brackets will be double clipped, or single clipped with double riveting may be substituted, to the bulkhead and to tank top and riveted to the angle stiffener of the tunnel. The edge laps of the tunnel will be double chain riveted and the butts will have treble riveted butt straps fitted.

The tunnel will be continuous from the engine room bulkhead to the aftermost bulkhead of the aftermost cofferdam. The shaft will pass through a stuffing box into the tunnel from the engine room, but the after end of the tunnel will be open to the dry hold.

If the engine room is fitted with a thrust recess which extends into the cofferdam, provision must be made for making this recess oiltight. Usually to accomplish this in any sort of an efficient way it will have to be rebuilt and made considerably stiffer than the original recess. The thrust recess will be open to the engine room and the stuffing box will be placed at the bulkhead forming the after end of this space. The tunnel will also be riveted to this plate. The end connections of this tunnel to bulkheads will be made by heavy single angles, double zigzag riveted.

Heavy shelves for the shaft-bearing pedestals will be fitted in the tunnel where required. These will consist of a heavy boiler plate flanged and riveted to the tunnel plating. The weight will be taken by two brackets fitted under the bearer plate and clipped to the tunnel.

As mentioned above, the tunnel ends at the after dry hold and provision must be made to suspend the spare tail shaft in the rear end of the tunnel or in this dry hold. This after hold must be designed so as to permit the withdrawal of the old shaft and the installing of the new. If possible, it would be a good idea to design the access hatch to the dry hold in such a manner that the tail shaft could be hoisted to the deck. However, in most cases a plate will have to be removed from the tunnel in one of the after tanks so as to allow the withdrawal of the tail shaft. Needless to say, this method involves a great deal of expense and time.

Oiltight Hatches

The oiltight hatches will be on the upper deck and there will be one for each tank. They should be arranged under, or as near under as possible, the large cargo hatches on the shelter deck, if such is fitted. If the upper deck is the weather deck, the hatches are best arranged as near to the center of each tank as convenient. In any case they ought to be kept clear of all bulkheads by at least one frame space.

The size of the hatches should be such as to allow easy access and give room to put one or more wind shutes down each hatch for clearing the tanks of gases.

A good method, and the one most commonly adopted, is to provide large hatches about 6 by 12 feet, with rounded corners and combings about one foot high. A flat bolted plate is fitted on top of the combing, and a small opening 6 by 4 feet is cut in this. This small hatch will be the oil-tight one, while the bolted cover can be used as a general cargo hatch, if desired, when oil is not carried.

The large hatches will be constructed by fitting a 3½-inch by 3½-inch by ½-inch angle to the heavy deck plates described under "Decks"; a combing plate of ½-inch steel will be riveted to the angles and carried to the bottom of the beams and clipped to them. The top angle will also be a 3½-inch by 3½-inch by ½-inch, and a ⅝-inch plate will be bolted to this top angle. Around the opening cut into this plate will be fitted a 3-inch by 6-inch bulb angle; lugs will be riveted to this to take the fly bolts. The hinged cover will be a ½-inch plate with an asbestos gasket held in place by two small angles or by a special casting. The bulb on the angle when cover is in place will form an oiltight joint with the gasket. Four slots will be cut into the edge of the cover plate to take the fly bolts and doubling plates will be fitted around the slots to prevent any deflection of the plate when bolting down. Two fly bolts will be fitted on each side of the hatch, and by unscrewing those on one side and slacking the ones on the other the cover will swing back as if on a hinge. The large plates will be bolted down oiltight to the coaming angles by ¾-inch closely spaced bolts. Lamp wicks soaked in red lead will insure a tight joint and will prevent corrosion. Since these hatches will be raised very seldom, we must make some provision against this action. A sketch of hatches is shown in Fig. 17.

An ullage plug 6 inches in diameter will be fitted in the center of each hatch. This will be a brass screw plug that is removed to take the density and temperature of the oil every day during the voyage.

Lifting rings must be provided so that the large hatches can be removed when desired. If the flat top has been stiffened by angles on the outside, slots may be cut into these angles to take a block and tackle.

In some cases it may be found advantageous to fit a continuous hatchway about 6 to 8 feet broad and 2 feet

high with the small oiltight hatches on top to each tank. In this case the transverse and longitudinal bulkheads must be carried up to the top of this trunk. The upper deck is then only fitted to the side of this trunk.

In the case of side summer tanks the hatches will be fitted in the same manner, but the large bolted plates will be made about 6 feet by 8 feet with 4-foot by 4-foot fly-bolt hatches located on top. Lifting rings and ullage arrangements must be made to fit stanchions and chains around these manholes when open.

Arrangements must be made to give access to the dry holds. The forward one can, as a rule, be reached from the hatches to the chain locker. The after one should have a hatch with a trunk way carried through the 'tween decks.

Ladders must be provided for access to all oil tanks,

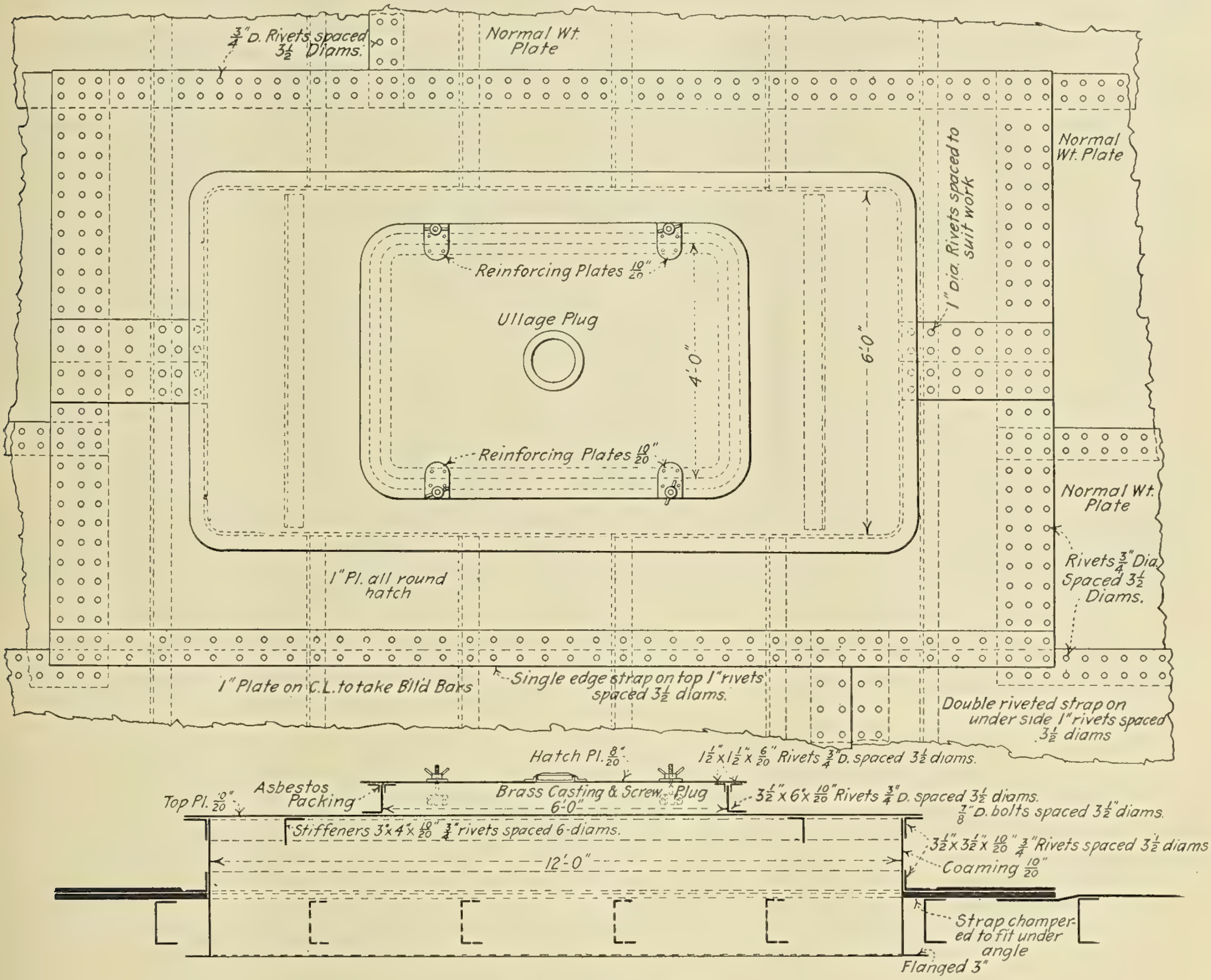


Fig. 17.—Oiltight Hatch

plugs will be fitted in the same manner as on the other hatches.

If the 'tween decks are used for coal or cargo, 6-foot by 12-foot hatches of the ordinary construction will be fitted with their wooden covers and tarpaulins. If the vessel is of the shelter deck type, corresponding hatches must be fitted on this deck. The number of these will depend upon the subdivision of the 'tween deck, but four on each side will be the usual number.

The cofferdams will also have oiltight hatches on the upper deck on each side of the centerline bulkhead. These will usually be oval manholes about 23 inches by 15 inches, although if considered desirable larger hatches may be fitted. These manholes may be of the hinged type with butterfly bolts or of the bolted plate type. The latter is, of course, cheaper, and would answer the purpose almost as well as the more expensive one. A low combing or a high combing may be used, but if the low type is used, cofferdams and pump rooms. These should be arranged as safely as possible and should not be fitted in one continuous length except in the cofferdams. In the pump rooms these ladders should be of the engine or stoke room type.

(To be concluded.)

United States Export Coal Trade.—The larger part of the export coal trade of the United States has been with other countries of the Western Hemisphere. Canada absorbs practically all of the anthracite that finds foreign purchasers and is also an important buyer of American bituminous fuel, while the republics to the south take most of the remainder of the "soft" coal. In the seven-month period ending January, 1915, anthracite shipments were but 135,986 tons, or 6 percent less than in the corresponding period of 1913-1914, whereas bituminous exports fell off 2,193,731 tons, or 20 percent.

The Red Star Liner Belgenland

Triple Screw Passenger Steamer of 33,000 Tons Displacement Launched by Harland & Wolff, Belfast

An interesting commentary on the present European war occurred, appropriately enough, on the last day of the year 1914 in the launch of a large new passenger steamer by Messrs. Harland & Wolff, Ltd., of Belfast. The name of this boat is the *Belgenland* and her port of registry is Antwerp, which indicates that some hope is entertained for the restoration of Antwerp to its former position in the commerce between Europe and America.

The *Belgenland* is a triple screw passenger steamer about 700 feet long and 78 feet beam, with a gross tonnage of approximately 27,000 tons and 33,000 tons displacement. She has been constructed on the latest and most approved principle, the double bottom extending right fore and aft and the watertight bulkheads carried up to the awning deck. There are seven steel decks besides the orlop deck and the bridge deck. Accommodation is provided for 660 first class, 350 second class and over 2,000 third class passengers, the first class accommodation including a number of cabines-de-luxe on the bridge deck. In addition to the usual first class dining saloon and reception room, reading and writing room, lounge and smoke room, will be a children's saloon, room for maids and valets, gymnasium and children's playroom, greenhouse, verandah, swimming bath and electric baths. The second class accommodation, which is also of a superior nature, will include a gymnasium.

Auxiliary Machinery

The appliances for working the ship and cargo will be of the latest type, the steering gear being of Harland & Wolff design, and the steam winches, windlass and capstan are very powerful, efficient and up to date. There will be a large refrigerating machinery plant. There is a large and very complete electrical installation consisting of four main steam-driven engines and dynamos having a combined output of 1,200 kilowatts and one 75 kilowatt auxiliary Diesel oil engine set. This latter is situated well above the waterline so that in case of emergency it can supply lighting throughout the ship, wireless telegraphy, boat winches, and also operate the electrically controlled watertight doors should the four main sets for any reason be put out of action.

In addition to the lighting, which will consist of about 4,500 25-candlepower lamps, the cabins are electrically heated and there is a complete system of warm air ventilation and suction fans, the control for all of which is grouped together at a central point, enabling the air to be kept fresh and the temperature normal at all seasons. Among other electrical apparatus, there are passenger elevators for convenience in getting from one deck to another, and also electrically operated hoists in connection with the stores. The boat winches are also electrically operated and there are in addition a number of service machines in the galleys, bakeries, etc.

The propelling machinery of the *Belgenland* consists of two sets of reciprocating engines driving the wing propellers, and one low-pressure turbine driving the center propeller. The reciprocating engines are of the inverted, direct-acting, four-crank, triple expansion type, balanced on the Yarrow, Schlick & Tweedy system, having four inverted direct-acting cylinders, 35½ inches, 56 inches, 64 inches, and 64 inches diameter by 5-foot stroke, designed for a working pressure of 215 pounds per square inch. The turbine is of the Parsons reaction type and designed to operate in the ahead direction only, by exhaust steam from the reciprocating engines.

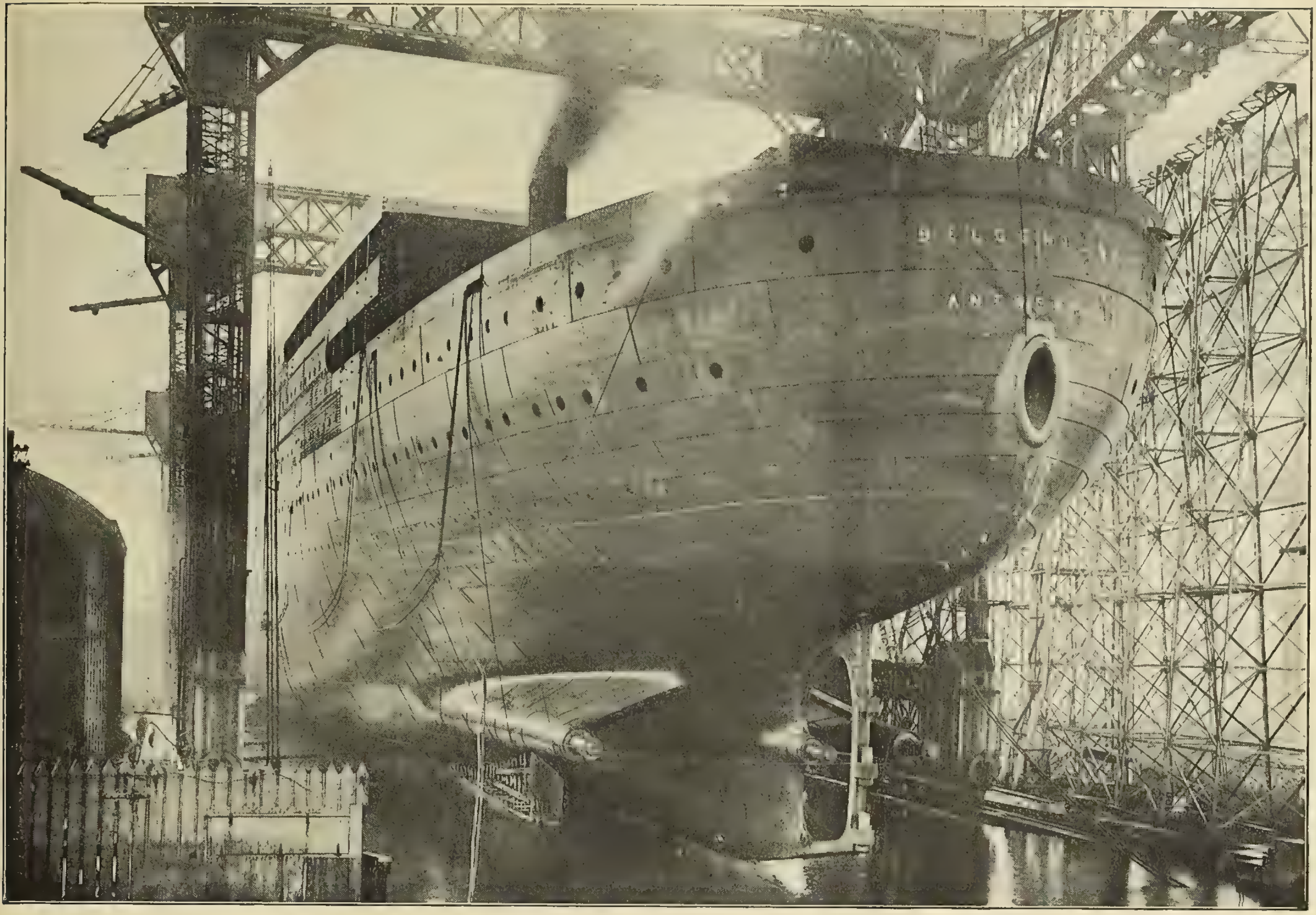
Details of Main Engines

The design generally is that adopted by Harland & Wolff, Ltd., and in construction the machinery embodies the builders' chief features and high class character. All the cylinders are independent castings of high grade cast iron with liners fitted to all of them, the bottoms of the cylinders being double, and strongly ribbed and arranged with loose boxes for carrying the metallic packing which is fitted for the piston rods and valve spindles. The cylinders and casing covers are of cast iron, box section, arranged to take escape valves, lubrication, etc. The columns supporting the cylinders are of cast iron, rectangular in section and firmly bolted to sole plates and all cylinders, the tops being securely connected together with tie bars. Loose guide plates are fitted to both front and back (the former being for the ahead motion) and both arranged for water circulation through them in order to carry away the heat which will be produced. The sole plate is of strong cast iron, box section, having nine half round recesses for shaft bushes arranged to take the crankshaft, which is built in four pieces with the angles arranged to suit the balancing of the engines.

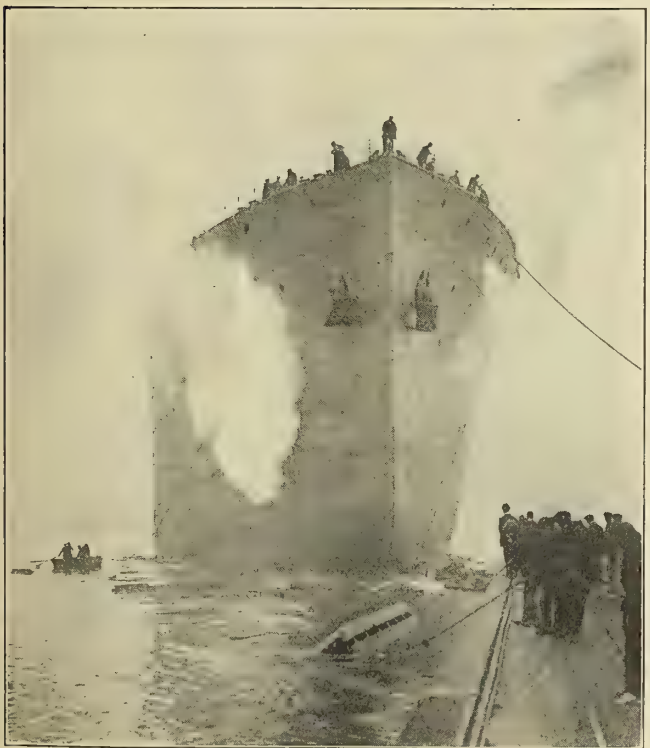
The high-pressure pistons are of cast iron, the intermediate-pressure and low-pressure of cast steel of conical shape, the weights of which have all been arranged to suit the balancing of the engine. The piston packing is of the Ramsbottom type for high-pressure and intermediate-pressure, and Lockwood & Carlisle for low-pressure, the junk rings being made specially deep for guidance, as no tail rods are fitted; all the cylinders are fitted with piston valves of hard, sound cast iron. The high-pressure and intermediate-pressure cylinders are arranged for steam to enter between the valves, the top piston in each case being larger in diameter than the bottom one to balance the weight of the valve and gear, while, in order to carry the weight of the low-pressure valve (which takes steam on the outside) and gear, balance cylinders are fitted.

The reversing is effected by two of Brown's steam and hydraulic type engines, each with a hand pump for pumping into the hydraulic cylinder when reversing by hand is required. The engines are arranged at the side of the high-pressure front columns with a hand pump in a convenient position. Attached to the sole plate of each engine is a turning engine, which turns the engine and shafting through worm wheel gearing, which latter can also be worked by hand. The governors are of Aspinall's type driven by lever from the high-pressure main engine crosshead and operate a small steam and hydraulic engine for working the throttle valve, means being provided for disconnecting the couplings and operating the engine by hand lever. An emergency governor is also fitted in connection with the main reversing engine, the reversing links being thrown into mid position when this emergency governor comes into action.

The low-pressure turbine, which is direct coupled to its line of shafting, has been designed as a compromise be-



Stern View of the Steamship *Belgenland* on the Building Ways at the Harland & Wolff Yard, Belfast. Length, 700 Feet; Beam, 78 Feet; Gross Tonnage, 27,000; Displacement, 33,000; Motive Power, Combination Reciprocating Engines and Low Pressure Parsons Turbine



The *Belgenland* Just After Launching

tween the propeller and turbine efficiencies and the weight, which is, of course, the usual procedure in marine practice. The turbine cylinder, bearing blocks and bushes are of cast iron, the latter being lined with white metal and arranged for forced lubrication. The rotor drum is of steel, hollow forged, the wheels of cast steel and the spindles of forged steel. The turbine is arranged with a dummy of such diameter that the steam thrust approximately balances the thrust of the propeller, but a thrust block is also provided at the forward end of the forward bearing block, having phosphor bronze rings fitted into steel carrying blocks. The blading is of brass of Parsons standard section.

Between the reciprocating engines and the low-pressure turbine change valves are fitted, so arranged that when maneuvering the exhaust steam from the reciprocating engines passes direct to the condensers without going through the turbine. The valves are of the balanced piston type fitted with Ramsbottom rings and worked by direct acting steam and hydraulic engnines operated from the starting platform. Electric power has been utilized for the lifting of the heavier parts of the machinery, and also for the turning of the turbine rotor and its line of shafting. A governor of the Proell type is fitted to the turbine and is arranged to operate the change valve engines, so that steam is shut off the turbine should the speed of the rotor become excessive.

The thrust of each propeller is transmitted by means of

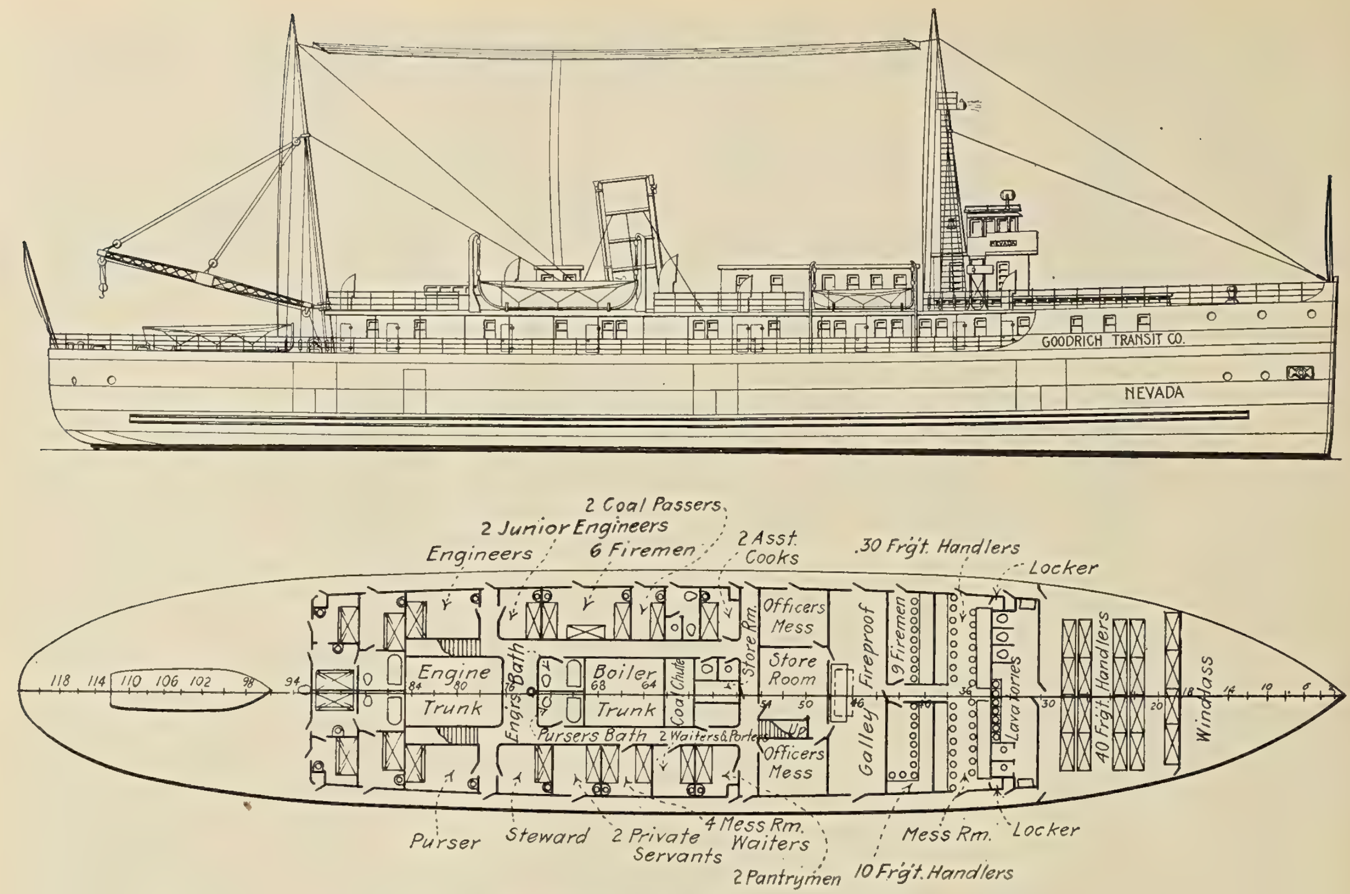


Fig. 1.—Profile and Deck Plan of Steamer *Nevada*

collars forged on to the thrust shaft to the thrust block, and is taken up on cast iron shoes lined with white metal on both sides, the weight of the thrust shaft being carried by two bearings, one at each end of the thrust block. All the shafting throughout the ship is of Siemens-Martin ingot steel, made by Messrs. John Brown & Co., Ltd., Sheffield, the plummer blocks for carrying the same being lined with white metal of Harland & Wolff's best quality, while the propeller shafts are fitted throughout the stern tube with a gun-metal liner in one piece. The whole of the shafting is considerably in excess, as regards strength, of that required by the Board of Trade or Lloyd's rules. The stern tubes are of cast iron fixed into stern frame and stern post by wrought iron nuts outside, and bolted with a flange to the bulkhead on the inside. Gun-metal bushes lined with lignum vitæ are fitted to the stern tubes, the inner end of the forward bush being arranged with a stuffing box and gland.

The wing propellers are fitted with three loose manganese bronze blades, each on a cast steel boss, the blades being secured to the boss with steel studs and forged bronze cap nuts. The turbine propeller is of solid turbadium alloy. On the aft end of each boss cast iron cones are fitted over the propeller shaft nuts.

Engine Room Auxiliaries

The condensers are pear-shaped, built of mild steel plates with cast iron water boxes, and are arranged with the steam branches the full length of the tube. They are also arranged so that the inlet circulating water enters the bottom and leaves at the top, the water being circulated by centrifugal pumps of the builders' own make, and of ample capacity for obtaining 28-inch vacuum on service. The condensate and air which enters the condensers are extracted by two independent pumps of Weir's dual type. These pumps deliver the water to two large feed tanks alongside, one on each side of the ship, each of which is capable of holding a ten-minutes' supply of feed water when the engines are running at full power. The feed water gravitates from the tanks to the control tanks on the hotwell pumps, passing through filters on its way, the two twin feed water filters being of Carruthers' make, arranged in pairs so that one can be cleaned while the other is in use. Two pairs of Weir's main feed pumps are fitted, of ample capacity, each being capable of dealing with the whole of the feed water at low speed, and discharging the same through a feed heater of Weir's make to the boilers.

In addition to the above auxiliaries, there are two sanitary, two bilge and three ballast pumps, all by Harland & Wolff and all of the duplex type. For dealing with the heating and cooking returns, a separate heater is fitted, circulated by the hotwell pump of Weir's make, while the condensation is drawn away by means of one of Weir's "Mono" type air pumps. For port use an auxiliary condenser of Harland & Wolff's pear-shaped make is fitted, circulated by a steam-driven centrifugal pump of Harland & Wolff's make. The air pump in connection with this auxiliary condenser is of Weir's "Mono" type. For feeding the boilers in port, one single cylinder pump of Weir's make is fitted in the engine room, and one pump of Harland & Wolff's make in the the compartment at the forward end of the boilers; while in addition a general service donkey pump of Harland & Wolff's duplex type is also arranged in the engine room.

In the engine room two fresh water distillers of Hocking's make for ship's use, and two evaporators of Weir's make are fitted, while for pumping the fresh water to the

deck two of Weir's single cylinder pumps of ample capacity are fitted. For the forced lubrication to the turbine bearings, two single cylinder double acting pumps of Weir's make are fitted, each pump being capable of dealing with the full quantity of oil required, while the other is a standby. These pumps draw from the drain tanks below the floor level and discharge through a cooler to the supply tank in the engine casing. For the forced lubrication of the center and wing shaft tunnel bearings, and also the wing thrust blocks and bearings, one single cylinder pump of Weir's make is fitted to draw from the drain tank and discharge to the plummer block supply tank. There are also arranged in the special electric engine room four electric engines of Allen's make, and a refrigerator with three pumps by Messrs. J. & H. Hall, Ltd.

The machinery spaces are well ventilated, eight 40-inch Sirocco fans being fitted for ventilating the boiler rooms with cross connections and suitable trunks led down to within 7 feet of the stokehold floor, while the engine room, in addition to natural ventilation, is fitted with two 45-inch Sirocco fans, these fans being electrically driven.

There are ten double-ended boilers 15 feet 9 inches diameter by 20 feet long, each with six Morison furnaces, the opposite furnaces being led into a common combustion chamber. The boilers have been constructed in accordance with the rules of the Board of Trade for a working pressure of 215 pounds per square inch, and are arranged to work with natural draft. Four patent hydraulic ash expellers are fitted in the boiler room.

It will be seen from the above that the *Belgenland* is finely equipped both from the passenger carrying and the engineering point of view, and it is to be hoped that at the completion of the construction the position of international affairs will be such as to give this new vessel her proper place in the important fleet which plies between the old world and the new.

Freight Steamer Nevada

The Manitowoc Shipbuilding & Dry Dock Company, Manitowoc, Wis., has begun work on a new freight steamer for the Goodrich Transit Company, Chicago, Ill. This vessel, which will be named the *Nevada*, following the custom of the Goodrich Line in naming its boats after States whose names end in an "a," will be 230 feet long over all, 212 feet 9 inches long on keel, 42 feet molded beam, 18 feet molded depth to main deck and 29 feet molded depth to spar deck.

The *Nevada* is built for the winter trade on Lake Michigan and has been specially designed to withstand

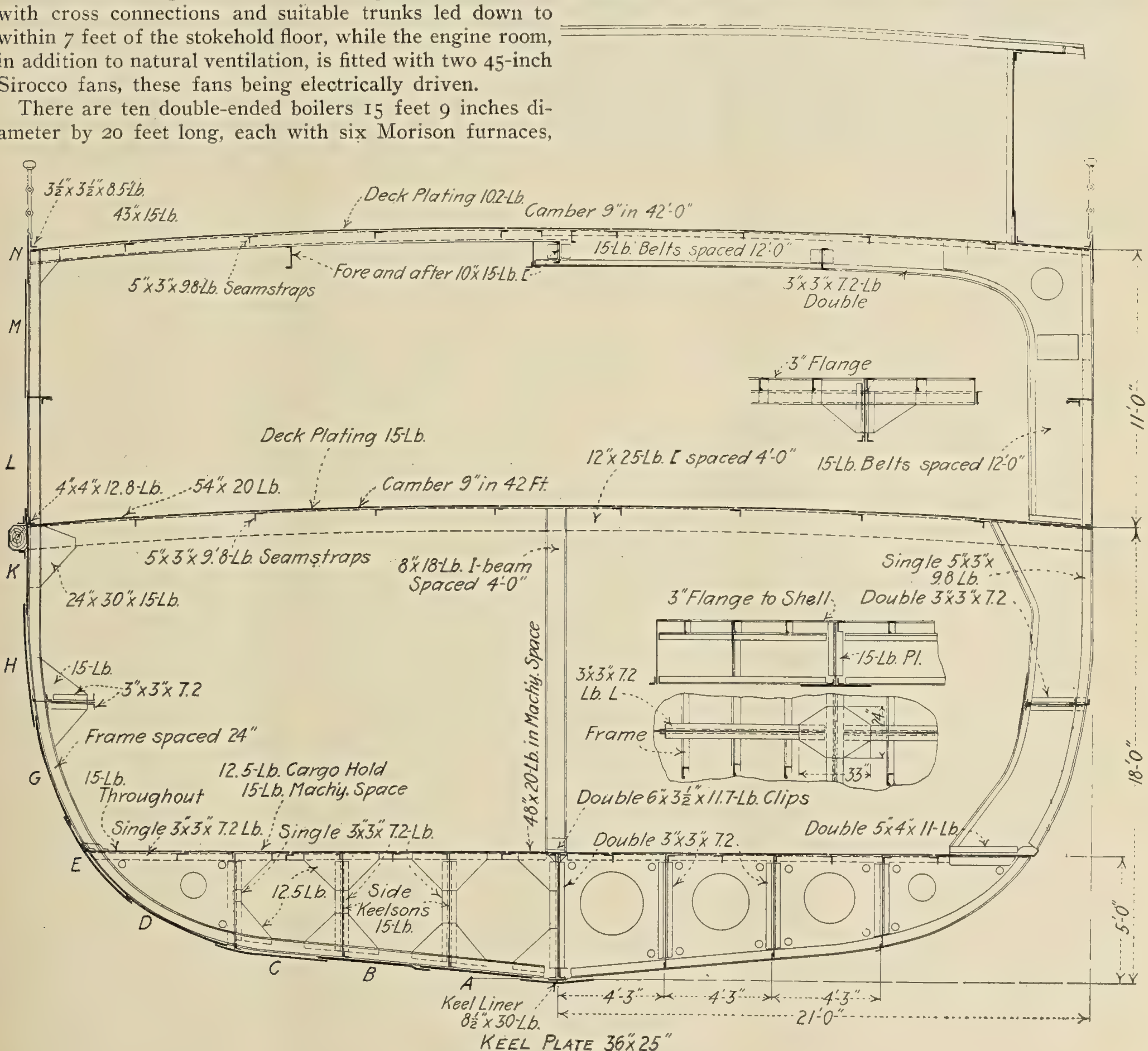


Fig. 2.—Midship Section of the *Nevada*

service in icebound waters, rather than to conform to any special rules. The main frames will be 6-inch bulb angles spaced 24 inches, with close spacing fore and aft. Thirty-inch belts of plate will be spaced about every 10 feet. There will be a 6-inch by 1-inch waterline strake all fore and aft, to avoid any corrugations from ice pressure. All bow plating will be ¾ inch or 1 inch thick.

Just below the waterline a 30-inch plate stringer will be fitted, and throughout the ship there will be a double bottom five feet deep. The hull is further subdivided into seven watertight compartments by transverse bulkheads. There will also be an orlop deck in the fore hold to give additional stiffness.

The spar deck will be supported by arch beams spaced 12 feet, there being no stanchions between the main and spar decks. The head room of 11 feet between decks will give plenty of height for freight, keeping clear of all piping, wiring, etc. There will be three large freight gangways and one supply gangway on each side of the ship. The forward gangway on each side will be 9 feet wide by 9 feet high to accommodate large trucks, etc. Three hydraulic freight elevators will be installed, one in each hold.

In addition to the steam fire extinguisher required by law, all freight space in the ship will be served by a sprinkling system. The vessel is so constructed that each freight hold can be completely shut off, so that in case of fire the damage will be limited to a small space. When the gangways are shut all openings through the spar deck can be securely locked, so that no one can gain access to the freight. Ventilation is provided for the main deck by six large ventilators running up through the cabin above.

Accommodations for a crew of seventy-five will be provided on the spar and upper decks. There will be separate wash rooms and mess rooms for all the different departments of the crew. Six rooms with two baths will also be provided on the spar deck for representatives of the owners, as well as a large room and private bath on the upper deck. The captain's and mates' quarters are on the upper deck directly below the pilot house. The wireless room is in a separate cabin on the upper deck aft.

The life-saving equipment includes two 50-person lifeboats and one 25-person life raft. A large launch will also be carried. This equipment, together with the life preservers, etc., will be in excess of the requirements of the new seamen's bill.

Propulsion is by a triple-expansion engine with cylinders 21½, 34½ and 56 inches diameter by 36 inches stroke, designed to develop 1,600 horsepower with a boiler pressure of 185 pounds per square inch, giving the vessel a speed of 17 miles per hour. The boilers are of the Scotch type, two in number, each 13 feet 3 inches diameter by 11 feet long, with three 40-inch furnaces in each.

The auxiliaries include extra large fire pumps, so that the vessel will be able to do excellent work as a fire boat. A boom 40 feet long with a capacity of 5 tons is fitted on the after side of the main mast for handling freight, and a three-drum hoisting engine will be installed for operating this boom. Freight that cannot be handled through the main gangway will be carried on the spar deck aft, which has been especially designed with this purpose in mind. In addition to handling heavy freight, the cargo boom will also be useful in case it is necessary to use the boat for wrecking purposes.

For mooring the vessel a two-drum mooring machine is fitted both forward and aft. A large towing bit, with the necessary chocks, will also be installed, so that the *Nevada* can come to the assistance of any other ship of the fleet that may be in trouble. All the latest safety devices will be installed and the vessel will be as safe as it is possible to make her. The fire danger has been especially guarded against.

The *Nevada* will be ready for service early in the fall and will be an innovation in vessels of this class.

Use of Oil Engines as Auxiliary Power for Sailing Vessels

Although oil engines were brought into use in the marine field about twenty-five years ago, it is only recently that they have begun to play an important part in the shipping trade, where steam has been the dominant power. Now that oil engines of large size are produced, which give a good account of themselves as far as reliability and economy are concerned, this form of power has made considerable headway in the field of auxiliary sailing vessels, and the prospects for the revival of sailing vessels in regular trade routes are very favorable.

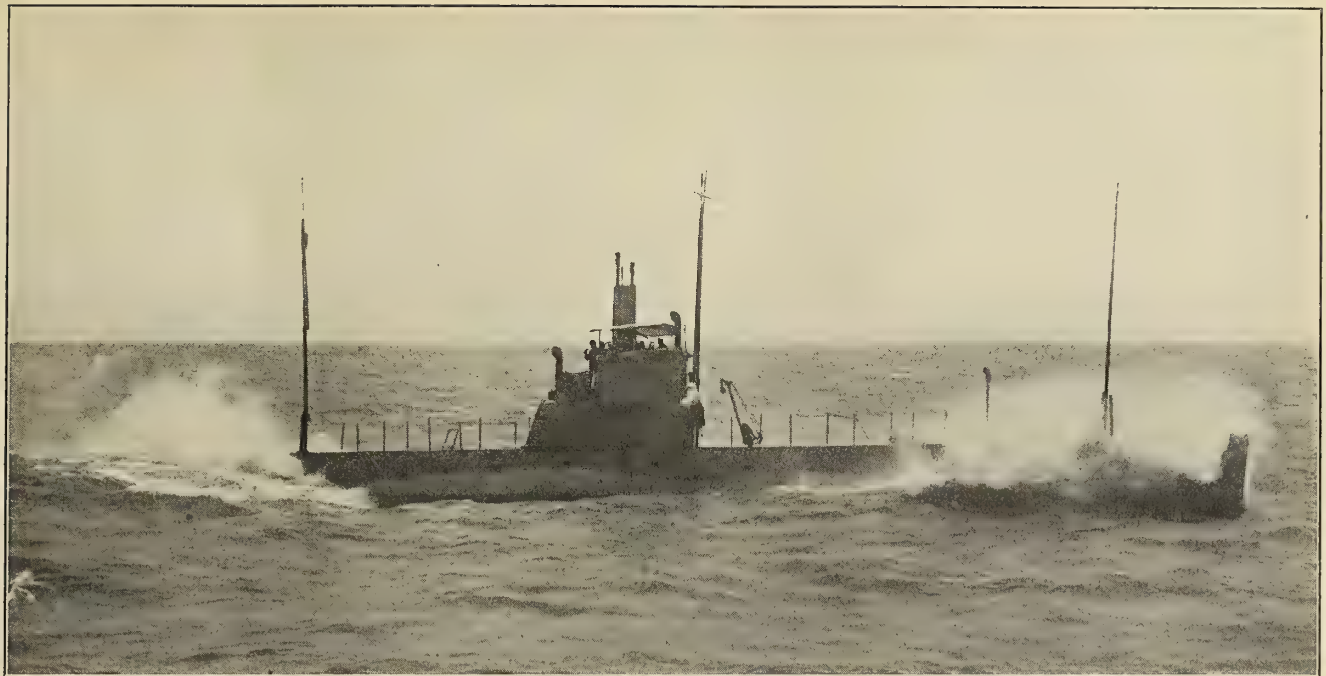
The principal advantages possessed by auxiliary sailing vessels, as compared with sailing vessels without power, are that the vessel is able, irrespective of weather and winds, to make her voyage within a fixed time, which enables her owners to obtain better freight rates. All towing charges are dispensed with and time is gained when handling the cargo by means of the power available for winches and booms. Greater safety is also assured for the ship in all weather and in dangerous waters. Under the present favorable conditions in the freight market, ship owners have seized upon the opportunity to press into service comparatively obsolete sailing vessels by installing in them heavy oil engines as auxiliary power, and cases are on record where the whole equipment of auxiliary machinery has been paid for by the profits of a single voyage.

A case in point is the fitting of the four-masted steel bark *Fingal,* owned by the Trans-Atlantic Motor Ship Company, Christiania, Norway, with two Bolinders engines, each of 160 brake horsepower. The *Fingal* is a ship of 2,435 tons net, and, as a sailing ship, has a large spread of canvas. The twin-screw arrangement of auxiliary machinery, aggregating 320 horsepower, was installed in four days, and the vessel, with 1,500 tons of ballast, was taken out on a trial trip on June 8, developing a speed of 7.5 knots against a moderate breeze without sailing power.

On this ship the engines occupy a comparatively small space, only about 3 to 4 percent of the ship. Fuel oil tanks are provided of sufficient capacity to supply the ship for a continuous voyage of 40 days. The fuel consumption for both engines is 1.5 tons per day of twenty-four hours at normal load.

As compared with a freight steamer, the auxiliary sailing vessel has shown favorable results. The average speed in both cases has proved to be about the same, the loading capacity is in favor of the sailing ship, the weight and space of the oil engine equipment being considerably less than that of the machinery equipment on a steam vessel. The initial and running costs and depreciation are also less and, when the vessel is idle, there are no stand-by losses or repairs to tanks, boilers, floor plates, firemen's wages, etc.

Recent installations of oil engines on sailing vessels have shown that, as compared with sailing ships without auxiliary power, profits in transporting freight have increased by about 50 percent or more.



(Photograph copyrighted by the International News Service)

Fig. 16.—Modern U.S. Submarine of Holland Type Fully Equipped for Long Voyage on the Surface

Modern Submarines in War and Peace—II

Development of the Submarine Beginning with 1893—Principles of Construction and Operation

BY SIMON LAKE *

When in 1893 the United States Congress appropriated $200,000 (£41,000) for a submarine boat and the Navy Department advertised for inventors to submit designs for such vessels, it was for the first time officially recognized that there *might* be possibilities in this type of boat. Most of the naval officers, however, were very skeptical of the practicability of such craft, and from the conservative point of view they were perhaps justified, as no satisfactory boat had up to that time been built.

A programme of requirements, which undoubtedly would produce a weapon valuable for defense, was made up by the Navy Department, and these requirements were designated in the following order of importance:

1. Safety.
2. Facility and certainty of action when submerged.
3. Speed when running on the surface.
4. Speed when submerged.
5. Endurance, both submerged and on the surface.
6. Offensive power.
7. Stability.
8. Visibility of object to be attacked.

This standard of accomplishments is as important today as when it was first promulgated.

This first appropriation was brought about by a recommendation to Congress, made by Commander Folger, Chief of Ordnance, who had been much impressed with the possibilities of submarines after witnessing a test of the Baker boat in Lake Michigan. Commander G. A. Converse, president of the Torpedo Board, also made a report certifying that it was his belief that a larger vessel operating on the Baker principles would, with some modifications, prove valuable for defensive and offensive purposes.

France at this time was the only other country that was giving official encouragement to the development of the submarine. She was conducting experiments with the *Gymnote*, a small vessel of the diving type, and had under construction a much larger vessel to be operated on the same principle. This vessel was afterwards called the *Gustave Zede*, but she did not go into commission for some time, as her submerged control was found to be bad. One report of her performance states that "with the committee of engineers on board, her performance, in attempting to keep an even depth line was most erratic and frequently a 30-degree inclination was reached before the boat could be brought up. On one occasion she hit the bottom in 10 fathoms with sufficient force to unseat the engineering experts."

The *Gymnote* was 5 feet 10 inches diameter amidships and 59 feet 10 inches in length. The *Gustave Zede* was 10 feet 9 inches diameter and 148 feet long. It is very difficult to secure sufficient metacentric height in a boat of the above proportions, which probably accounted largely for their erratic behavior submerged.

In response to the United States Government's advertisement for designs of submarine boats, only three inventors submitted plans and specifications. They were Mr. George C. Baker, Mr. J. P. Holland and the author. Mr. Baker submitted designs of a boat 60 feet in length and of about 120 tons displacement. This vessel was expected to have a speed of about 8 miles per hour. The

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method of submerged control and known characteristics were the same as have already been described in connection with his boat as built in 1892. Mr. Holland proposed to build a vessel 85 feet in length, 11½ feet diameter and 168 tons submerged displacement and 154 tons light displacement.

This gave a surface "reserve of buoyancy" of only 14 tons, or less than 10 percent. The method of control was by the use of vertical and horizontal rudders on the same principle as was used in his *Fenian Ram*, described in the July issue.

In 1897 Mr. Holland published in *Cassier's Magazine* an article on submarine navigation which gives some of his experiences with the *Fenian Ram*. This article very well explains the state of the art of submarine navigation in 1893. One of the early difficulties encountered was to know the direction one was going when submerged. Referring to his experience in the *Fenian Ram*, Mr. Holland said:

"Experience with submarine boats had been so very limited up to 1881 that more difficulty in steering a straight course by compass while submerged than while moving on the surface was scarcely expected. The writer had no suspicion that his boat could not be steered perfectly until he tried it after making about half a dozen preliminary dives to adjust the automatic apparatus. Having become doubtful of the reliability of the compass, he had it carefully compensated, and then made a trial submerged run in New York harbor, heading the vessel towards a point which he knew was about twelve minutes' run distant.

"The boat dived at an inclination of about 15 degrees, and it was noticed that when she again reached a horizontal position the compass needle swung around a complete circle and vibrated a good deal before coming to rest. The boat was then discovered to be about 90 degrees off her course. It was steered again in the proper direction, and then inclined upward at a sharp angle to find whether the action of the compass would be as erratic while rising as while running downward. One end of the needle dipped to the bottom of the cup when beginning the ascent, and remained there during the rise. When the boat approached a horizontal position, a few feet below the surface the needle swung around as violently as it had done during the boat's descent, and then came to rest again at a point that indicated the boat to be far off the true course.

"As it appeared quite clear that the run was not made in the direction intended, and that about one mile must have been covered from the start, ten minutes having already passed, the boat was brought to the surface of the water just in time to prevent her from running on rocks that lay about twenty yards straight ahead and sixty yards down from the starting point.

"The boat had been started to run over one mile up stream, and the mile-run ended sixty yards down stream with the boat heading exactly opposite to her original direction. This erratic action of the compass was discovered to be due to heeling, or inclining from the horizontal position, and that it could not be corrected in that boat on account of the near proximity to the compass needle of considerable masses of iron that were liable to have their position changed while the vessel was submerged."

To overcome the above-mentioned difficulties, Mr. Holland invented a device and took out a patent (No. 492,960) for a triangular drag, which was expected to keep the vessel on a true course when under water. This triangular drag was the novel feature of Mr. Holland's 1893 design and was intended to automatically steer the vessel on a straight course when submerged. It was intended to operate on the following ingenious principle:

Holland's Steering Device

While the vessel was running on the surface the steering gear was under the control of the steersman. In this condition the compass could be adjusted, as the vessel was on a substantially level keel and the masses of metal remained fixed in their relation to the compass, but when the vessel was caused to "dive" the masses of metal changed their relation to the adjusting magnets and the compass was thrown out of truth. Therefore, on beginning a dive the vessel was first started on the surface on the course it was intended to follow submerged until the triangular drag, being drawn through the water, assumed "a direction parallel to the axial line of the boat by reason of the rush of water against said drag, and especially against the rib thereon." As soon as the boat was on her course, the steersman was expected to disconnect his hand steering gear and allow the drag to control the rudder to hold her to her original course. Mr. Holland maintained that any departure from a straight line will immediately cause the drag to produce a swinging motion of a lever, which was expected to throw the rudder in a reverse direction, thus returning the ship to her original course.

Another automatic steering device operated by the pressure of the water was expected to automatically control the depth of submergence, it being only necessary, theoretically, to move a control lever to a point on a dial corresponding to the desired or "predetermined" depth of submergence and the horizontal diving rudder would then be automatically manipulated to incline the bow of the vessel down so as to dive, until the desired depth was reached, and then to be manipulated to throw the bow up or down to maintain that depth.

In further describing his 1893 design for the *Plunger*, for which he had received the award based on a guarantee of performance, Mr. Holland describes her as follows:

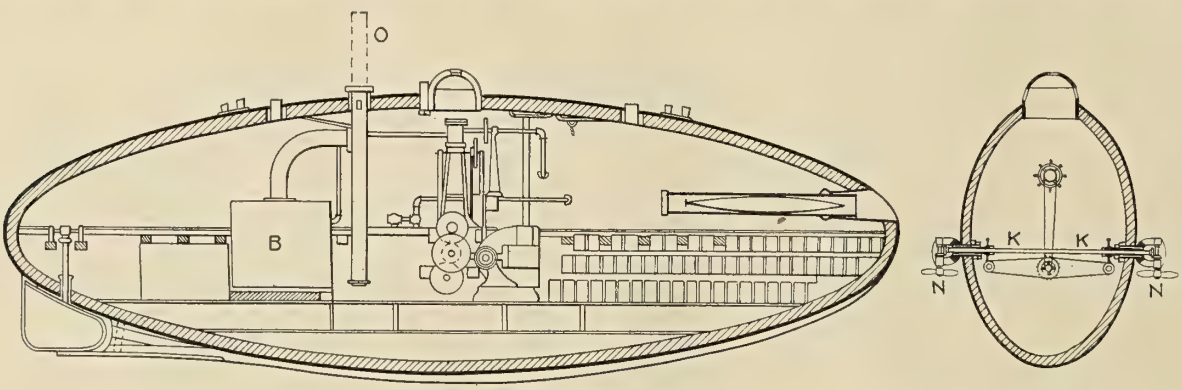


Fig. 17.—The Baker Submarine

The novel feature of this design was the side propellers, N-N, carried in revolving housings which were rotated by the depth-control man so as to exert a thrust in the proper direction to "push" or "pull" the vessel downward and forward at the same time. The propellers were driven by the athwart shaft, K-K. A steam boiler, B, furnished steam for surface propulsion and accumulators forward supplied power for submerged work. O was a telescoping smokestack.

"The boat now being built for the United States Government satisfies all the requirements detailed earlier in this article. It will have a length overall of 85 feet; diameter, 11½ feet; total displacement, 168 tons, and a light displacement of 154 tons. The guaranteed speed on the surface will be 15 knots, the speed awash 14 knots, and submerged 8 knots. At full speed the boat will have an endurance of twelve hours and a radius of action of 1,000 miles at slower speed. The endurance, when submerged, will be ten hours at a speed of 6 knots.

"The boat will be propelled by triple screws, operated by three independent sets of triple expansion steam engines, capable of developing 1,625 indicated horsepower. There will also be electric storage batteries and a motor of 70 horsepower for submerged running. The armament will consist of two expulsion tubes and five Whitehead torpedoes.

"Steering on the horizontal plane while submerged is accomplished by an automatic apparatus that performed very well in one of this boat's predecessors. Steering in the vertical plane is also done automatically, and with considerable exactness, while submerged. Steering in both planes can also, at the same time, be controlled manually.

"There will be a steel armored turret, 4 feet high, to protect the pilot and smokestack, and the hull will be covered by 3 feet of water while the vessel runs awash to attack.

"When engaged in harbor defense duty its position will be outside the outer line of harbor defenses—that is, beyond the range of the guns defending the entrance. While performing this duty it will lie awash—that is, with only the top of its turret over the surface of the water. On the approach of an enemy's vessel the smokestack will be shipped and the aperture on top of the turret through which it passed will be quickly closed watertight. She will then run in a direction to intercept the enemy's ship, still remaining in the awash condition, until she comes near enough to be discovered by the lookouts on the ship, when she will go from the awash to the entirely submerged condition. The distance from the ship at which she will dive will depend on the weather. In rough weather she can come quite close without being observed.

"Having come within a distance that the operator estimates at two or three hundred yards from the ship, the diving rudders are manipulated so as to cause the top of the turret to come for a few seconds above the surface of the water. During this short exposure of the turret—much too short to give the enemy a chance to find its distance and train a gun on it capable of inflicting any injury—the pilot ascertains the bearing of the enemy's ship, alters his course or makes another dive if necessary. If he finds that the submarine boat is within safe striking distance, say 100 yards, a Whitehead torpedo is discharged at the ship. A heavy explosion within six seconds after the torpedo is expelled will notify the operator that his attack has been successful, and he may then devote his attention to the next enemy's ship that may be within reach.

"When the boat is running on the surface of the water, with full steam power, and it becomes necessary to dive quickly, the pilot gives the order, 'Prepare to dive.' The oil fuel is instantly shut off from the furnace, the valves are opened to admit water to the water ballast tanks, an electric engine draws down the smokestack and air-shaft into the superstructure, and moves a large, massive sliding valve over the aperture on the turret through which the smokestack passes. These operations will be completed in about thirty seconds, when the boat is in the awash condition and prepared to dive. In twenty seconds more it will be running horizontally at a depth of twenty feet below the surface of the water and quite beyond the reach of the enemy's projectile."

The author submitted designs of a twin screw vessel, 80 feet long, 10 feet beam and 115 tons displacement, with 400 horsepower steam engines for surface propulsion and 70 horsepower motors for submerged work. This design introduced several new and novel features into the art of submarine navigation which have been the cause of considerable scientific discussion. The design called for a *double hull* vessel, the spaces between the inner and outer hulls forming water ballast tanks; the design also called for twin screws and four torpedo tubes, two firing forward and two aft.

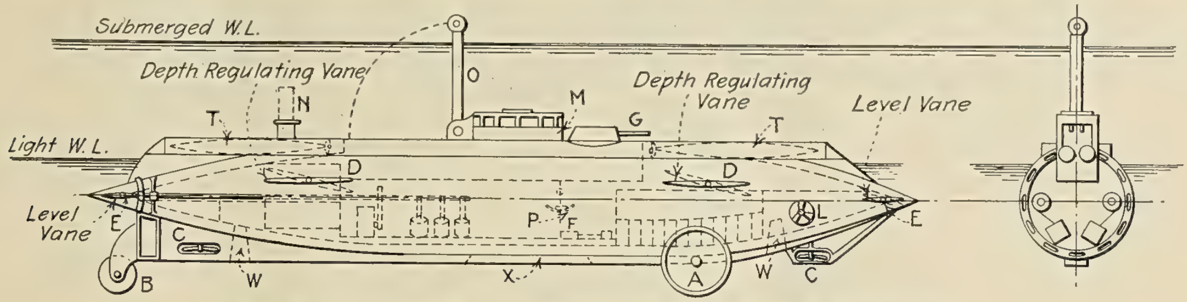


Fig. 18.—Lake 1893 Design as Submitted to the U.S. Navy Department

Novel features consisted in (A) wheels for running on the bottom; (B) rudder forming also a steering wheel when navigating on the bottom; (C-C) propellers for holding vessel to depth when not under way; (D-D) depth regulating vanes or "hydroplanes" for causing vessel to change depth while under way and to accomplish the changes of depth on an even keel; (E-E) horizontal rudders or "leveling vanes" designed to automatically hold the vessel on a level keel when under way; (F) a weight automatically controlled by a pendulum; (P) mechanism to correct trim; (G) gun arranged in watertight revolving turret for defense purposes or attack on unarmored surface craft; (L) propeller in tube for swinging vessel at rest to facilitate "pointing" her torpedoes; (M) conning tower; (N) telescoping smokestack; (O) observing instrument arranged to turn down on deck when under way; (T-T) torpedo tubes, two firing forward and two aft; (W-W) anchoring weights to hold the vessel at rest at any desired depth between the surface and bottom; (X) an "emergency keel" which would be automatically released if the vessel reached an unsafe depth. She was a double-hull vessel, water being admitted to the space betwen the inner and outer hulls and in trim tanks forward and aft to effect submergence. A diving compartment was also provided to enable the crew to leave or enter the vessel while submerged.

Lake's 1893 Design

The new and novel feature which attracted the most attention and skepticism regarding this design was (the author was later informed by a member of the Board) in the claim made that the vessel could readily navigate over the waterbed itself and that while navigating on the waterbed a door could be opened in the bottom of a compartment and the water kept from entering the vessel by means of compressed air, and that the crew could, by donning diving suits, readily leave and enter the vessel while submerged.

Another novel feature was in the method of controlling the depth of submergence when navigating between the surface and waterbed. The vessel was designed to always submerge and navigate on a level keel rather than to be inclined down or up by the bow to "dive" or "rise." This maintenance of a level keel while submerged was provided for by the installation of four depth regulating vanes which I later termed "hydroplanes" to distinguish them from the forward and aft leveling vanes or horizontal rudders. These hydroplanes were located at equal distances forward and aft of the center of gravity and buoyancy of the vessel when in the submerged condition, so as not to disturb the trim of the vessel when the planes were

inclined down or up to cause the vessel to submerge or rise when under way.

I also used, in conjunction with the hydroplanes, horizontal rudders which I then called "leveling vanes," as their purpose was just the opposite from that of the horizontal rudder used in the diving type of vessel. They were operated by a pendulum controlling device to be inclined so as to always maintain the vessel on a level keel rather than to cause her to depart therefrom. When I came to try this combination out in practice I found hand control of the horizontal rudders was sufficient. If vessels with this system of control have a sufficient amount of stability, they will run for hours and *automatically maintain both a constant depth and a level keel,* without the depth control man touching either the hydroplane or horizontal rudder control gear.

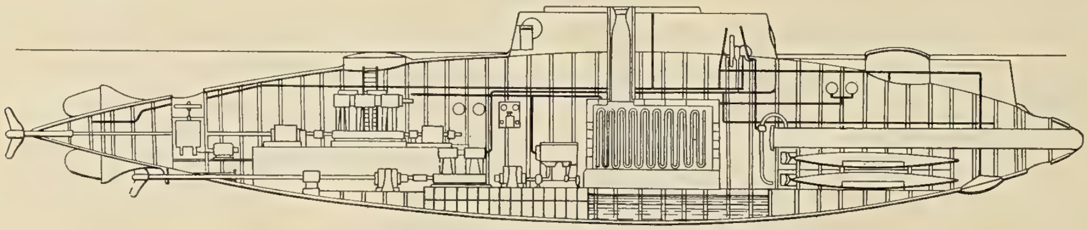


Fig. 19.—The *Plunger* (Holland Type Submarine), Launched in August, 1897

(Machinery not drawn to scale. The engines of 1,600 horsepower, with the necessary auxiliaries, nearly filled the after portion of the vessel.)

This automatic maintenance of depth without manipulating the hydroplanes or rudders was a performance not anticipated nor claimed in my original patent on the above mentioned combination, and what caused these vessels to function in this manner remained a mystery, which was unsolved until I built a model tank in 1905 in Berlin, Germany, and conducted a series of experiments on models of submarines. I then learned that the down pull of a hydroplane with a given degree of inclination varied according to its depth of submergence, and that the deeper the submergence, the less down pull. This works out to give automatic maintenance of depth as long as the vessel is kept at a constant trim on a substantially level keel, and I have known of vessels running for a period of over two hours without variation of depth of one foot and without once changing the inclination of either the hydroplanes or the horizontal rudder.

Fig. 20.—The *Plunger* (Holland Type) Ready to Launch

Novel features of her design were automatic "diving" and steering devices, triple screws, armored conning tower and a large steam power plant.

The capability of this arrangement of hydroplanes and horizontal rudders to control the depth of submergence was questioned and doubted for many years. As late as 1902, nearly ten years after I first submitted this method of control to the United States Navy Department, Naval Constructor L. Y. Spear, U. S. N., testifying before the Committee of Naval Affairs, House of Representatives, in reference to the "Lake even keel boat" and my use of hydroplanes, said, "As an expert I do not think he will make his hydroplanes work," and strongly contended that submergence by inclining the vessel itself was the proper method.

Several years later, in 1908, in Paris, I met Captain Laubeuf, the celebrated French naval constructor, who has perhaps done more towards perfecting the French submarines than any other designer, and he informed me that after the French Government had their sad experience in the loss of the *Lutine* and *Farfadet* with their crews, they had changed all their diving boats into even keel boats and were now using substantially my method of even keel submergence with hydroplane control. He also informed me that they had, at that time, thirty-five new boats under construction to operate on the even keel principle, eighteen of which were of 550 tons displacement. Captain Laubeuf was kind enough to compliment me as having been the first to introduce this method of submerged control.

Commander Murray F. Sueter, Royal British Navy, in his most complete work on "The Evolution of the Submarine Boat, Mine and Torpedo, from the Sixteenth Century to the Present time," published in 1907, said:

"After scrutinizing all the information available I am certain that several features of the 'Lake' design will be embodied by most nations in the construction of future boats, the chief of which, perhaps, are 'the even keel method of submergence' in preference to the 'dynamical dive' of the Holland boats; also the provision of a safety keel and diving compartment. This latter forms a ready means of communicating with the surface should the boat, through some small mishap, find herself on the bottom and unable to rise."

Sir Trevor Dawson, formerly (R. N.) manager of "Vickers," in discussing submarine boats before the Institution of Naval Architects in 1907, said:

"Mr. Lake mentioned the question of the importance of horizontal stability and the use of hydroplanes. I think these have been used by the Holland Company in America in connection with the experiments they made for the American Government. In one of the boats I saw they gave me particulars of such experiments. I know, too, that they have been used considerably in France with satisfactory results, and I think his contention as to the importance of horizontal stability, as things exist to-day, is fully justified."

Captain Edgar Lees (R. N.), who was the officer in charge of the British submarines, said:

"I may say, with regard to the features that Mr. Lake has brought to our notice, the hydroplane, for instance, and get-

ting good freeboard and seaworthy boats, the mere fact that they have been largely copied and that most nations build these submarine boats is, Mr. Lake contends, a conclusive proof that he has been for years on the right tack. Well, I do not think at the present moment submarine boats are being built in any country without hydroplanes, in order to dive, if desired, almost horizontally."

One of the latest contract requirements of the United States Government, specifying the characteristics of the

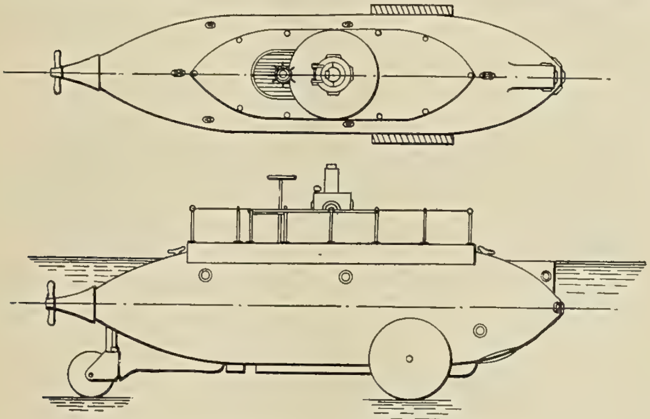


Fig. 21.—*Argonaut* as Originally Built

Surface buoyancy about 12 percent.

new boats to be built under the appropriation for submarines for the year 1915, states:

"The vessel shall make also the necessary trials to demonstrate her ability to effect initial submergence, to maintain submergence underway, and to change depths without exceeding an angle of inclination of one (1) degree." This, in substance, calls for "even keel submergence" when one considers that it was common for early boats of the diving type to take on an inclination of 15 to 20 degrees, and inclinations of as much as 45 degrees were not unknown.

All governments and submarine builders have now in their latest boats adopted the method of even keel submergence by the use of hydroplanes, and the author is much gratified that this method of control has been finally adopted as the standard, as I believe none of the latest modern submarine boats will make the uncontrollable dives to the bottom, common in the boats of the diving type, and which have been accompanied in many cases by the loss of their crews.

The author did not make a proposal to build a boat from his designs as submitted in 1893, but offered to co-operate with the Government in developing submarines under his patents, which were then pending, on such terms as the Government might desire. Not being fortunate enough, however, to secure the financial assistance of the Government in developing my inventions for the protection of our country, I turned my attention for a time to applying my inventions to commercial purposes and to prove the practicability of navigating on the bottom.

The Argonaut

For this purpose I built, in 1894, a small wooden vessel called the *Argonaut, Jr.* This vessel was provided with three wheels, two on either side forward, and one aft, the latter acting as a steering wheel. When on the bottom the wheels were rotated by hand by one or two men inside the boat. Her displacement was about 7 tons, yet she could be propelled at a moderate walking gait when on the bottom. She was also fitted with an air lock and diver's compartment, so arranged that by putting an air pressure on the diver's compartment equal to the water pressure outside, a bottom door could be opened and no water would come into the vessel. Then by putting on a pair of rubber boots the operator could walk around on the sea bottom and push the boat along with him and pick up objects, such as clams, oysters, etc., from the sea bottom.

Experiments with this vessel on the bottom of Sandy Hook Bay convinced sufficient people who were permitted to witness the experiments that submarine navigation in this manner was practicable, and I succeeded in raising sufficient capital to build a larger vessel to continue my experiments on a larger scale. Therefore, in 1895, I designed the *Argonaut.*

At this time I was living in Baltimore, Md., so I made a contract with the Columbian Iron Works & Dry Dock Company of that city for her construction. This company was also building for the Holland Torpedo Boat Company the *Plunger,* which was being constructed for the Government under the 1893 appropriation. Both vessels were completed about the same time. They were launched in August, 1897, and went into dry dock together.

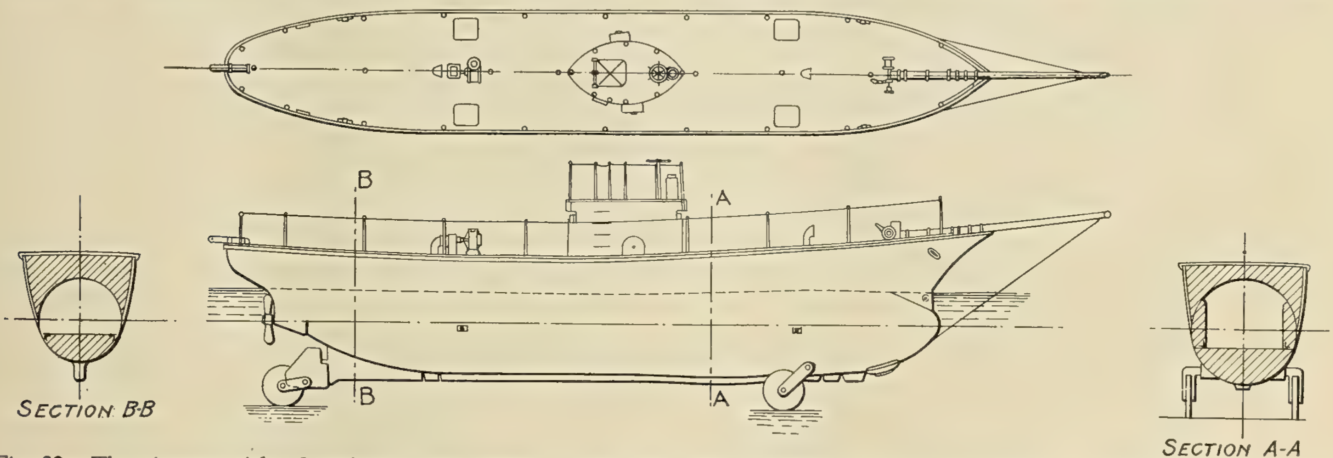


Fig. 22.—The *Argonaut* After Lengthening and Addition of Buoyant, Shipshaped Superstructure, Increasing the Surface Buoyancy Over 40 Percent

The bowsprit formed a hydraulic cushioning device to prevent injury in case of a head-on collision with an obstruction when running on the bottom. On encountering an obstruction of less height than the bowsprit, the bobstay acted as an inclined plane, and would lift her bow up so she would go over. A 6-inch pump is shown mounted on her after deck, which was used in transferring coal from a sunken vessel to a submarine freight boat.

The *Argonaut* as originally built was 36 feet long and 9 feet in diameter. She was the first submarine to be fitted with an internal combustion engine. She was propelled with a 30 horsepower gasoline (petrol) engine driving a single screw propeller. She was fitted with two toothed

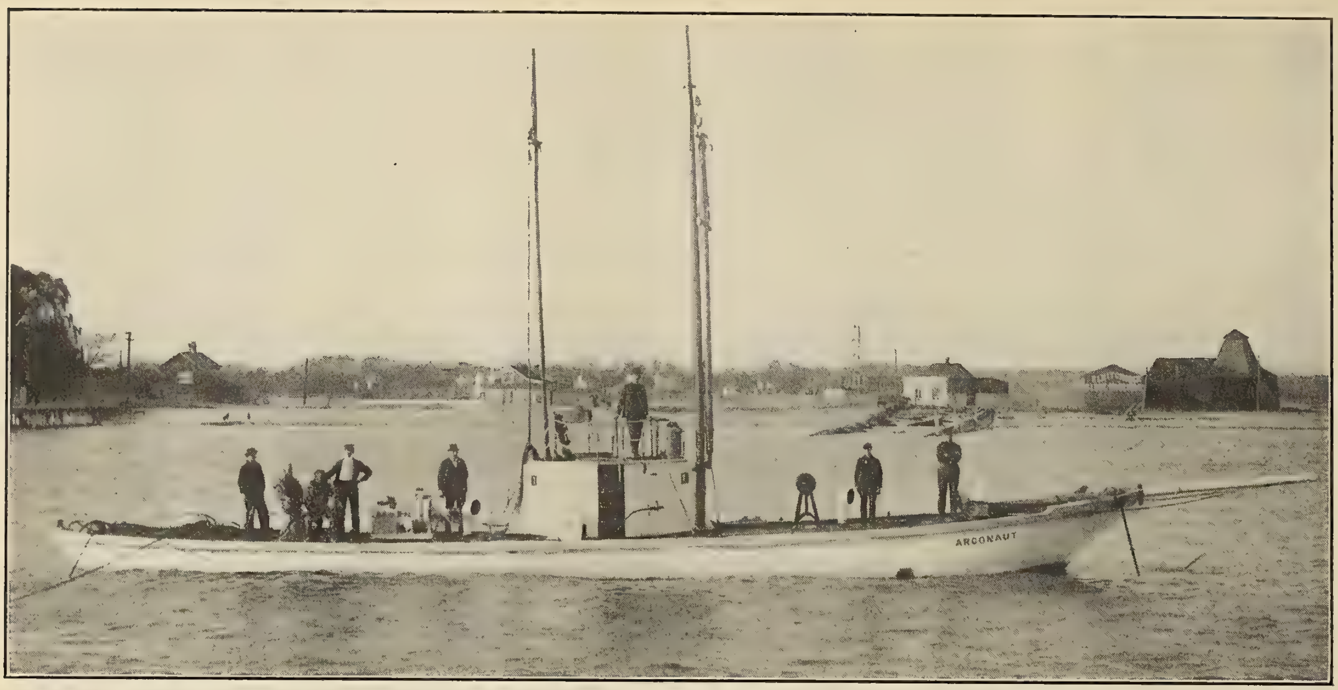


Fig. 23.—View of the Lake Submarine *Argonaut*, Showing Shipshaped Superstructure

driving wheels forward which were revolved by suitable gearing when navigating on the waterbed, or they could be disconnected from this gearing and permitted to revolve freely, propulsion being secured by the screw propeller. A wheel in the rudder enabled her to be steered in any direction when on the bottom. She also had a diver's compartment to enable divers to leave or enter the vessel when submerged, to operate on wrecks or to permit inspection of the bottom or to recover shellfish. She also had a lookout compartment in the extreme bow, with a powerful searchlight to light up a pathway in front of her as she moved along over the waterbed. This searchlight I later found of little value except for night work in clear water. In clear water the sunlight would permit of as good vision without the use of the light as with it, while if the water was not clear, no amount of light would permit of vision through it for any considerable distance.

Propelling Machinery of the Argonaut

As the *Argonaut* was built principally to further test out the possibility of navigating on the waterbed in exploration and commercial work, she was propelled both when on the surface and submerged by her gasoline (petrol) engines. Storage batteries were carried only for lighting purposes. The air to run her engines was first drawn down into the vessel through a hose extending to a buoy floating on the surface. Later she was fitted with pipe masts, which enabled her to navigate on the bottom in depths up to 50 feet. She functioned satisfactorily from the start. We found we could readily navigate over any kind of bottom, soft or hard, by regulating her buoyancy to suit, and she would, due to her buoyancy, readily climb over any obstruction that did not reach higher than her forefoot.

There were three things that caused us to delay for a few weeks her departure on a submarine exploration trip. The first was the escape of gasoline (petrol) fumes in the boat. When first built, fuel tanks were built in the hull itself and formed an integral part of the vessel. Special care was given to make these fuel tanks tight. They were tested under hydraulic pressure and found to be tight, but the fumes from gasoline (petrol) are very searching and after filling the fuel tanks and keeping them filled over night, gasoline (petrol) fumes were found to exist in the boat the next morning to such an extent that I would not venture to make a start until a fuel tank had been built outside of the vessel, where any escape of fumes would not form an explosive mixture. I followed this practice in all our later gasoline (petrol) engined boats, which largely eliminated the danger from carrying gasoline (petrol) as a fuel. A number of explosions have occurred, in some cases with fatal results, from gasoline (petrol) fuel being carried in built-up tanks within the hull itself.

The next cause of delay was due to the escape of and collection of carbon monoxide within the vessel. This developed on our first submarine run. After we had been down about two hours, some of us commenced to experience a dull pain at the base of the brain and great lassitude. On coming to the surface a couple of our men collapsed completely, and one was very sick all night. I could not understand the cause of this, as nothing of the kind had occurred in my previous hand-propelled vessel, so we made another submerged run the following day, and after about the same period of time the pain in the head and lassitude came on again. I then discovered that the engine would occasionally backfire out into the boat and that gas was escaping by the piston rings into the base of the engine and from there into the boat.

To overcome this difficulty I installed what I called an induction tank, which was piped up to the air intake of the engine and also the engine base. A check valve admitted air into this induction tank. When the engine was started the check valve was automatically lifted and induced a flow of air through the tank, in which a slight vacuum was maintained, which also served to draw the gases out from the engine base. In case of a backfire, the check valve automatically closed and the gases from the backfire were caught in the induction tank, from which they were drawn out on the next stroke of the engine. This solved this difficulty and thereafter the air was always

fresh and pure when running submerged, even after a submergence of several hours' duration.

Like Mr. Holland, I also had difficulty on our first submergence in always knowing "where we were going." Our compass was first installed in the boat itself, where it was surrounded by steel. The compass adjuster had searched for and found what he considered the most "neutral" place in the ship to install the compass, and had adjusted it by magnets in the usual manner, but it was too "logy" for correct navigation and we were forced finally to install it in a bronze binnacle directly over the conning tower, where it could be viewed by mirrors from the steersman's station. This cut out most of the adjusting magnets and the compass was nearly accurate on all courses. Submarine navigation thus became reliable.

Capabilities of the Argonaut

On the completion of these changes the *Argonaut* was taken down the Chesapeake Bay to Hampton Roads, where several months were spent in examining the bottom conditions in the bay and out on the ocean, and in locating and picking up cables and in examining wrecks. The Spanish-American War was on at this time and an effort was made to interest the Government officials in charge of the mines at Fortress Monroe. I tried to get some of the officers to go down in the *Argonaut* and see how easily by observation mine cables could be located and cut if desired, as I was making almost daily submerged runs in their vicinity. Finally I received peremptory orders not to submerge within a mile of the mine fields, as I might accidentally sever one of the cables, and then, as the officer in charge said, "There would be the devil to pay in Washington."

It was about this time that Admiral Sampson's fleet was holding at great expense its long vigil outside of Santiago, waiting for Cervera's fleet to come out. Our fleet was kept outside the harbor for fear of the mines, while here in Hampton Roads all this time was a vessel capable of clearing away the mine fields, but which was not given serious consideration, as it was thought that the submarine was impracticable. Experiments were also made showing the possibility of submarines establishing submarine telephone stations at known locations on the bottom of the ocean. In January, 1898, while the *Argonaut* was submerged, telephonic conversation was held from submerged stations with Baltimore, Washington and New York.

The Voyage from Norfolk to New York

In 1898, also, the *Argonaut* made the trip from Norfolk to New York under her own power and unescorted. In her original form she was a cigar-shaped craft with only a small percentage of reserve buoyancy in her surface cruising condition. We were caught out in the severe November northeast storm of 1898 in which over 200 vessels were lost, and we did not succeed in reaching a harbor in the "horseshoe" back of Sandy Hook until three o'clock in the morning. The seas were so rough they would break over her conning tower in such masses I was obliged to lash myself fast to prevent being swept overboard. It was freezing weather and I was soaked and covered with ice on reaching harbor.

This experience caused me to apply to the *Argonaut* a further improvement for which I had already applied for a patent. This was to build around the usual pressure resisting body of a submarine a shipshape form of light plating which would give greater seaworthiness, better lines for surface speed, and make the vessel more habitable for surface navigation. It would, in other words, make a "seagoing submarine," which the usual form of cigar-shaped vessel was not, as it did not have sufficient surface buoyancy to enable it to rise with the seas, and the seas would sweep over it as they would sweep over a partly submerged rock.

Addition of Buoyant Superstructure

The *Argonaut* was therefore taken to Brooklyn, 20 feet added to her length, and a light watertight buoyant superstructure of shipshape form added. This superstructure was opened to the sea when it was desired to submerge the vessel, and water was permitted to enter the space between the light plating of the shipshape form and the heavy plating of the pressure resisting hull. This equalized the pressure on the light plates and prevented their becoming deformed due to pressure. The superstructure increased her reserve of buoyancy in the surface cruising condition from about 10 percent to over 40 percent and she would rise to the seas like any ordinary type of surface vessel, instead of being buried by them in rough weather.

This feature of construction has been adopted by the Germans, Italians, Russians, and in all the latest type of French boats. It is the principal feature which distinguishes them in their surface appearance from the earlier cigar-shaped boats of the diving type. This shipshape form of hull is only suited to level keel submergence and must be controlled by hydroplanes.

I also departed from the cigar-shaped inner hull and was granted a patent on a form of pressure resisting hull with rising axes. This improvement overcame the tendency to "dive by the head" common to the cigar-shaped form, increased the surface speed on an equivalent displacement, and gave a considerable increase in metacentric height over a vessel of equivalent length and beam.

(*To be continued.*)

Davits and the New Requirements*

BY HARRY W. BROADY †

The new law requires many more lifeboats for passenger steamers than were required in the old rules. A very important question for the shipowner to settle is the stowage of all these new lifeboats. A certain minimum number of davits are required, depending upon the length of the ship. There will almost always be more lifeboats required than sets of davits. These extra lifeboats can be stowed in different ways. They may be nested—i. e., two lifeboats, one on top of the other, under one set of davits. They can be double banked under double-acting davits—i. e., two units, one inboard of the other, with single or nested boats in each unit, all to be served by one set of davits. There can be several units of lifeboats arranged across the deck, handled by one set of davits, by means of some feeding arrangement which places the boats under the davits. It has been previously stated that it is not a safe policy to place too many boats under one set of davits. This is especially true when the boats are of large capacity. The limit should not be over 300 persons, or, say, four boats for one set of davits, and that only where all the mechanical arrangements are of the best and safest types, so that the handling of the boats can be carried out quickly and with certainty in any emergency.

* Concluded from the July issue.

† Chief Engineer, Welin Marine Equipment Company, Long Island City, N. Y.

One single nest of two boats can be taken care of by all the different classes of davits, if suitable chocks, easily disengaged grips and non-toppling blocks are provided. The latter is especially important for recovering the falls for launching the second boat.

Double-banked boats under one set of davits can only be taken care of to advantage by trolley and track davits and double-acting quadrant davits. The round-bar and

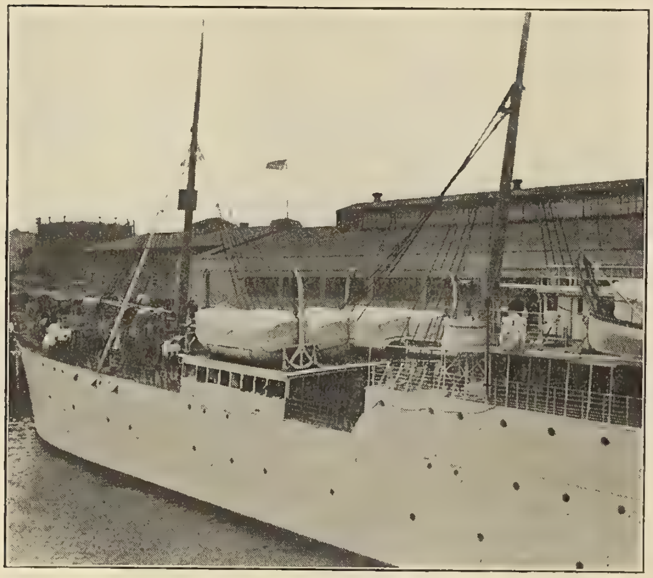


Fig. 10.—Installation of Double-Acting Welin Quadrant Davits

the pivoted davits would have to be provided with such long arms and the power required to swing the inside boats out would be so great as to make it impossible to work them by hand. Gravity davits are, of course, entirely out of the question. The trolley and track davits will, as previously mentioned, be rather heavy and complicated, but the mechanically operated quadrant davit is peculiarly well adapted for double acting. It is only necessary to increase the quadrant and extend the frame somewhat inboard, thus making it possible to swing the arm in over the inner boat. They are now extensively used. In some cases the inner boats are placed on a deck above. The davits have then been designed to reach over and handle this upper boat as well as the boat directly in the way of the davits. This has worked very well in practice. Double acting Welin quadrant davits are shown in Fig. 10.

Many different schemes have been worked out for feeding boats placed inboard to the davits. A very unique and efficient way was adopted on board the Cunard liner *Aquitania*. Ordinary double acting Welin quadrant davits were placed on the deck at the side of the ship in the usual manner. Double acting Welin quadrant davits were placed inboard in way of the other davits; they were fitted with powerful chain blocks to readily lift the boats. These inboard davits act as feeders for the outboard davits.

Marine railways running athwartship are also used for feeding the boats, but they will be very complicated if they are to be effective. They will in most cases be a very troublesome obstruction on the decks, as shown in Fig. 11, where the complicated driving gear, which is difficult to get at, can be seen.

Single Davits and Booms

Single davits and booms are sometimes used on board ships for launching boats. They ought never to be used for any boat except dinghies or working boats, as there is always the danger of spilling people out of a boat handled in one single whip. The state of equilibrium is very sensitive in a boat hanging like this in the air. The booms are generally used for launching pontoon or second class boats stowed far inboard. These boats are more like rafts and will float off a ship when sinking, if they do not foul in rigging, etc. It is therefore just as well that provision is made for launching them with a boom when the power and time are available.

Hoisting and Lowering Controls

Hoisting and lowering controls are now used to some extent on board of big liners. The height from the boat deck to the water will in some cases on big transatlantic liners be as much as 70 feet. With triple blocks, this means about 500 feet of about 1½-inch diameter hemp rope. By using wire falls and hoisting and lowering controls, double or perhaps single blocks can be used. The advantages in such a case are very clear, especially as the davits almost always take care of several boats, and by this means the recovery of the blocks and tackle can be made in very quick time.

A hoisting and lowering control is a very complicated affair, if it is to be effective. The two drums, one for each davit falls, must be worked simultaneously so as to make the lowering safe. It is practically impossible to work the mechanical brakes on two independent drums so evenly that the boat will always be on an even keel. In the case of simultaneously working drums they must also be arranged so that the drums can be worked independently. This is necessary to be able to bring the inclined boats to an even keel when the ship is heeling or to set the ropes up taut after the boat has been recovered and is in the chocks. The hoisting control must be provided with gearing for quick recovery of the falls in order to launch the remainder of the boats on the deck in turn, and also with gearing for slower recovery of the boats, both gears being arranged to work either with power or hand drive, as may be required. The power supply should be inde-

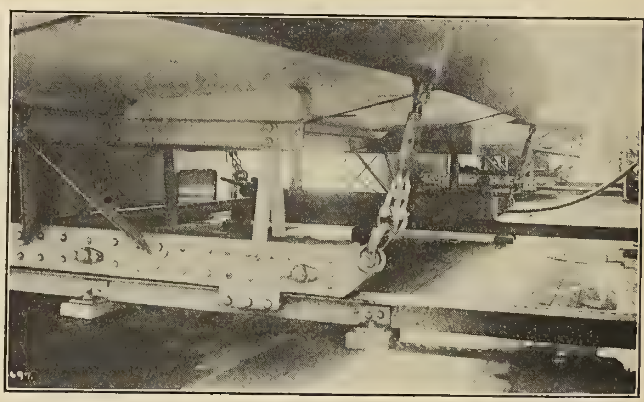


Fig. 11.—Athwartship Marine Railway

pendent of the driving power of the ship. Electric motors and storage batteries are most reliable.

There are many schemes patented in this line. Some have a lowering gear in each lifeboat, which is quite impossible, as it will take up too much room and will be very expensive. A very neat arrangement has been installed on board the big Hamburg-American liners *Imperator* and *Vaterland*, as shown in Fig. 12. The inventor is Mr. Axel Welin of London. The drums are in one casting and are placed on an eccentric shaft so that they can be moved by a lever either against the shoe of a brake or against a friction drive. In the neutral position the drums run freely on the shaft. The adjustment of the boat to an even keel is made possible by an independent gear consisting of two

drums and a worm gear drive. The standing parts of the falls are wound one around each drum and in opposite directions. By turning the drums one line is taken in while the other is paid out; thus the whole thing is balanced and it requires very little power to adjust the boat to an even keel. This can be done, if necessary, even when the boat is being lowered.

Another interesting hoisting and lowering arrangement is the use of a spool drum. This type was used extensively in a very crude form on whaling ships. The hoisting gear

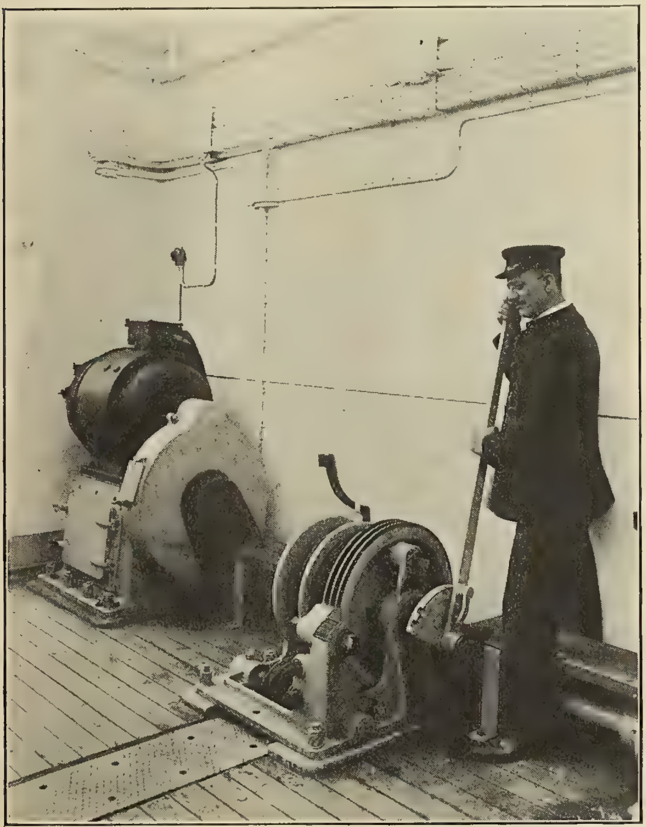


Fig. 12.—Hoisting and Lowering Control on the *Vaterland*

was provided with a third drum around which a driving rope is wound. When the lifeboat is to be hoisted up this rope is connected to a rope leading to and worked by a winch. The trouble with this arrangement is that the driving rope must be wound up each time before using, in most cases by hand.

The winches can always be used on board ship when they are in running order for hoisting up a lifeboat. This only necessitates a few snatch blocks on deck and a line from the winch to the davits.

Under all conditions the ordinary rope falls bent around a suitable bollard or belaying pin is the safest way for lowering away a lifeboat. The falls are then under absolute control. It is also the cheapest and simplest way, not requiring experience or special training, which is of utmost importance in times of disaster.

Testing of Davits

The new rules necessitate actual testing of the davits on board a ship. This is quite an expensive and bothersome operation. The ship will have to be first listed to the prescribed maximum list and the empty boat swung out on the high side. The list must then be increased to 15 degrees and the loaded boat swung out on the low side. Both of the above operations have to be carried out to test each set of davits, for all davits on board.

The only thing that happens when the loaded boat hangs in the fully swung out arms on the low side, when the ship is listed to 15 degrees from an upright position, is that the stresses in the davits increase. How great the increase of the stresses is with fully loaded boat and 15 degrees list can very easily be graphically laid out. This is shown for round-bar, pivoted and quadrant davits in Figs. 13, 14 and 15. The graphical method is so simple that it is not necessary to further explain it. For round-bar davits

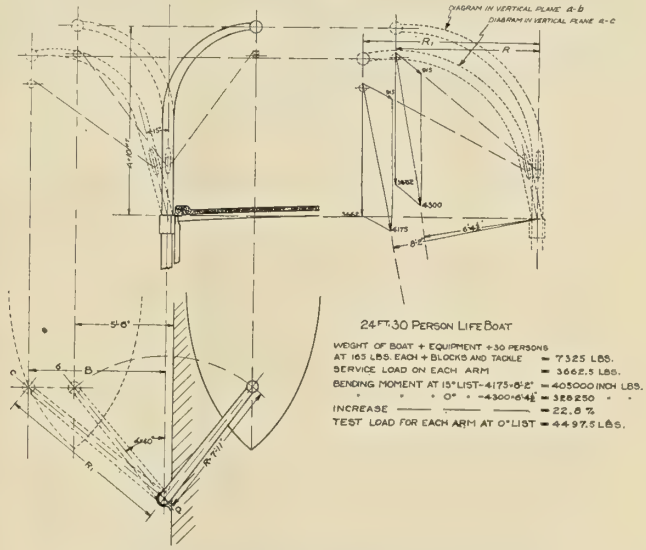


Fig. 13.—Diagram of Stresses, Round-Bar Davit

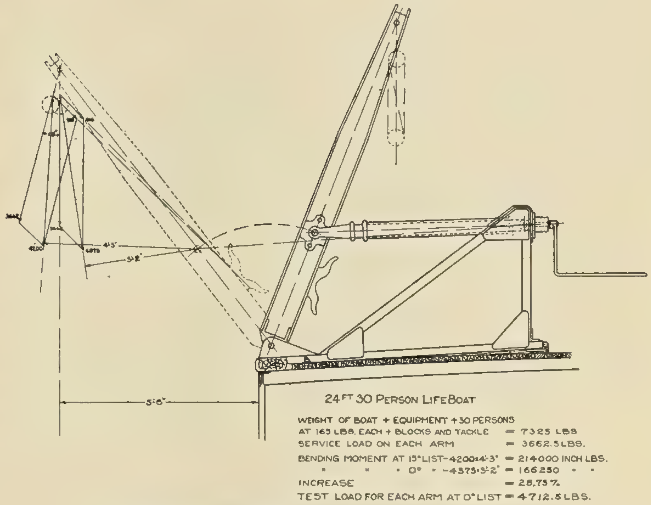


Fig. 14.—Diagram of Stresses, Broady Davit

the following empirical formula is also worked out and will give results sufficiently accurate:

Increase percent =

$$\frac{100}{R}\sqrt{(.259A + .966B)^2 + R^2 - B^2} - 100. \qquad (3)$$

A = height of davit above bearing bracket in feet.
B = outreach — distance between center line of boat in extreme outboard position and fore and aft line through the centers of the vertical part of the davits when ship is in upright position. Dimension in feet.
R = radius of overhang of davit arm in feet.

Or

Increase percent =

$$\frac{100}{R}\sqrt{(.259A + .966R \sin. \alpha)^2 + R^2 \cos.^2 \alpha} - 100. \qquad (4)$$

Where A and R are the same as above.

α = angle between davit in outboard position and fore and aft line.

Example:

$A = 10'$, $R = 7'\ 11''$, $\alpha = 40°$. See Fig. 13.

$$\frac{100}{7.9}\sqrt{(.259 \times 10 + .966 \times 7.9 \times \sin. 40°)^2 + 7.9^2 \times \cos.^2 40°} - 100 = 22 \text{ percent.}$$

Turning out the empty boat against the maximum possible list with quadrant and pivoted davits is equivalent

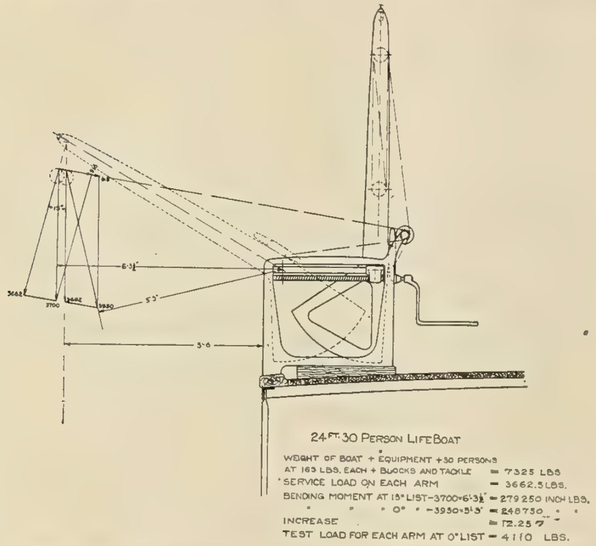


Fig. 15.—Diagram of Stresses, Welin Quadrant Davit

to turning out the boat with the ship in an upright position, but with an increased load. The increase is fully met in using a test load to give the increase in stresses due to a 15 degree list as determined above. The proposed manner of testing davits to comply with the law is satisfactory for pivoted and quadrant davits. The rule will not do for round-bar and trolley and track davits, however, as a simple increase of load with the ship upright will not give the same conditions for turning these davits out as when the ship is listed. In the latter classes there is only the friction to overcome with the ship upright in

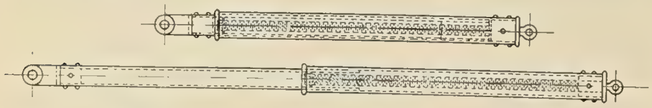


Fig. 16.—Broady Telescopic Screw in Closed and Extended Positions

turning out the boat, but with the ship listed there is a gravity force to overcome, and this increases very rapidly with increasing list.

The writer has worked out the following method, which will simplify the testing, and therefore might be adopted by the authorities:

By this method, if the davits are tested on board ship, it is not necessary to list the ship to obtain exactly the same conditions in regard to the davits that exist when the ship has listed. The davits could just as well be tested and approved at the builders' plant by the official inspectors, just as lifeboats are now inspected and approved.

Rule for Testing Davits

A test weight is hung in each davit arm when in the inboard position, the arm is then fully swung out and the weight removed. When the davit is fully swung out with the above test weight the stresses in the davit arm will be the same as those set up with one-half the service load fully swung out in davit arms with list of 15 degrees on board ship. This is to apply to quadrant and pivoted davits for requirements both as to strength and operation, but for round-bar and trolley and track davits, only as to strength.

The above test weight is to be such as to give the increase in stresses as determined in accordance with above described graphical method, also for round-bar davits by formula (3).

Example.—Davits: Height = 10 feet, radius of overhang = 7 feet 11 inches, a = 40 degrees. Increase in accordance with formula (3) = 22 percent.

Boat: 24 feet by 7 feet by 3 feet — 30 persons capacity.

Weight:

Boat	2,050 pounds	
Equipment	200 "	
Thirty persons at 165 pounds...	4,950 "	
Tackle and blocks	125 "	7,325
Increase 22 percent............		1,611
		8,936

$$\text{Test load per arm} = \frac{8{,}936}{2} = 4{,}468 \text{ pounds.}$$

After the davits have been originally tested, the official annual inspection and the required lifeboat drills will insure that the davits are always in good running order.

Factory Test of Davits

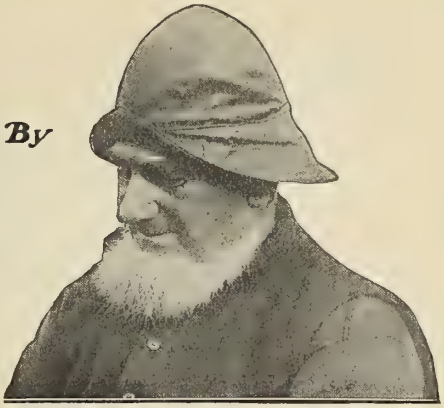
There ought to be some universal method adopted for testing davits at the factory where they are built. The following method adopted by the manufacturers of the Welin quadrant davits is suggested: All the davit parts are carefully inspected before machining. The steel castings are tested for tensile strength, elongation and bending. They are all carefully annealed. The completed davit is bolted on a floor plate. The position of the eye on the fully swung in arm is determined by a plumb line. A test load 30 percent to 100 percent greater than the maximum service load is suspended directly from the eye and the arm is fully swung out. The test load is removed and the arm swung back. The arm is then plumbed again to see if there is any permanent deflection. The least sign can be detected in this way. The arm is passed if there is no permanent deflection, otherwise it is broken up and thus destroyed. Tackle and blocks are then hung in the eye and a test load of about the weight of the empty boat is hung on the tackle and block and the arm fully swung back and forth to determine that all the working parts are in first-class condition. The working of all the parts are thus tested for twice the actual load they ordinarily are subjected to when worked on board the ship.

Any method of this kind would give perfect confidence that the davits will work well and stand up when they are needed in the saving of human life.

Lloyd's Shipbuilding Returns.—The returns compiled by Lloyd's Register of Shipping show that, excluding warships, there were 442 vessels of 1,506,923 gross tons under construction in the United Kingdom at the close of the quarter ended June 30. This is nearly 81,000 tons less than at the end of last quarter and about 215,000 tons less than the tonnage building twelve months ago.

A Record in Ship Construction.—By delivering the Bull steamer *Edith,* a steel ship 338 feet long by 5,000 tons deadweight capacity, in the short space of five months the Maryland Steel Company, Sparrows Point, Md., has established a record in shipbuilding. The keel for the ship was laid February 16, she was launched June 16, and delivered a month later.

Economy Talks By "Old Scotch"



Why Brass is an Expensive Luxury in the Engine Room

Two or three months ago I served notice that I was going to continue my long-winded yarns on economy in general. I sure have the economy bug in my system and I want to inject that bug in some more marine engineers —so watch out that you don't get infected.

I think I warned you in one of my other talks to beware of brass in building machinery and in repairing it, for there is where the money flies. I well remember the first ship I ever sailed on. To look down into her engine room when it had just been cleaned up would nearly blind you. Polishing paste was bought by the crate, and about half the time in port was spent in shining things up. Handrails, handwheels, gage boards, bands around the lagging, oil feeders, oil drips, and about everything in sight except the cylinders, columns and rods were either made of brass or else ornamented with it.

Nowadays it is all changed. Seems to me that every new engine I look at has less and less copper and brass, and, after all, it is a mighty good thing from the engineering standpoint. Polished steel handrails are stronger than brass and look just as good when you get used to them. Russia iron lagging looks as good as walnut staves and brass bands, and costs a darned sight less. Cast steel eccentric straps are stronger and better than composition, and when they are lined with white metal are just as efficient. Malleable iron squirt cans may not be so gaudy as sheet brass cans, but you can squirt oil just as far and just as straight with them, and they only cost one-third as much. Of course there are some parts of the machinery where you can't avoid using some brass or copper, but they are growing fewer all the time.

Besides the original cost of the yellow stuff, did you ever notice all the trouble it gives you? If you put it in valves or pipes that are used around salt water you're up against it for sure. Our old friend "galvanic action," or electrolysis, as the highbrows calls it, gets in its work at once, and the first thing you know you're down on your belly or knees in the bilges wrapping some pipe to stop a leak. About an hour or so after you've stopped one leak, you're lucky if the oiler doesn't come up to you and report another pinhead leak in the same length of pipe. Then I'd hate to listen to your language. If you don't happen to put great quantities of zinc around your sea valves or in your condenser heads, then you find the cast iron or steel plates being eaten away.

Oh, I tell you this copper and brass business does make lots of trouble. Of course we still have to use it in our surface condensers, and that's half the cause of trouble in the boilers, as it is not content with chewing away the condenser heads, but it must needs "pizen" the feed water and start a row in the boiler inwards by setting up pitting on the unsuspecting plates. Brass in condenser tubes not only starts all kinds of fusses with iron or steel, but it soon starts a row in its own midst; the zinc fights with the copper, and the first thing you know the old condenser needs a new set of the trouble makers, and, believe me, that costs some money these days, with copper at 30 cents (1/3) a pound and zinc even more than that.

A fellow showed me a sample of condenser tubes made out of this new stuff called Monel metal the other day. You know that's about 60 percent nickel, and they say there's nothing much doing in the "eating away" business when it gets in contact with other metal. It costs over a dollar (4/2) a pound, but I think it would be economy in the end to use it even at that price, as it wouldn't have to be removed every three or four years like some of these brass tubes we are now using.

Copper fire mains, you all know, are another source of trouble. If they are not thoroughly drained, and very often they are not, the salt water remaining in them starts galvanic action, and the first thing you know it leaks like a sieve. One of the big shipyards thought they had solved the whole fire main difficulty by using extra heavy wrought iron pipe and lining it with lead expanded tightly in the pipe. As they say on the stage, that "listened very well." But on nearly every ship where these lead-lined pipes were fitted they have found that, in spite of all the pains they took to prevent it, the salt water would leak in between the lead and the iron around the flanges, and then it was good-bye iron pipe. You could almost hear the scrap going on between the lead and the iron, and the result has been leaky fire mains again. This same firm has now gone back to first principles and uses extra heavy wrought iron or steel pipes for their mains and has them heavily galvanized. They last longer than copper, are stronger, and you can bet very much cheaper. If any of you have any leaky copper fire mains to repair, I would advise you to sell the copper to the junkman and put galvanized iron piping in its place.

A prominent designing engineer once told me that any fool could build an engine with plenty of brass around it and make it run, but that it took a good man to use only iron or steel and build a successful engine. Judging from the way they get up recent marine engines, all the designers nowadays must be wise men, for I'm blamed if I have seen any of them recently where you can find enough brass in sight to make a pair of earrings for a Hottentot.

So, to close my remarks, I must repeat, that if you want to save money around marine work, "Cut out the brass, for it costeth like the dickens and troubleth all the time."

Yours for economy,

Old Scotch

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbiulders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Four-Bladed vs. Three-Bladed Propeller

Q.—Will a four-bladed propeller of the same pitch and diameter as a three-bladed one do any more work?

A.—Operating at the same revolutions per minute, a four-bladed wheel should give about 12 to 15 percent more thrust.

Advantages of Open Rod Valve Gear

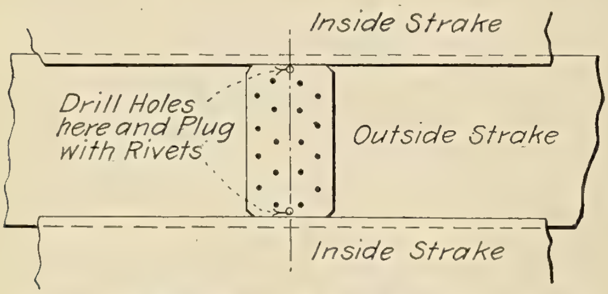
Q.—Will you please tell me why, with the ordinary Stephenson link valve gear which is used on marine engines, the open rod type is so much more common than the crossed rod? C. R.

A.—Where it is intended to operate the engines linked up to any considerable extent, the rods should be of the open type, as they permit of a greater range of expansion and less reduction of port opening than crossed rods.

Stop Waters for Single Strapped Butt Joints

Q.—Is there any special precaution taken with single strapped butts of outside strakes of shell plating in the nature of stop waters? C. S.

A.—Yes, they should be provided with stop waters. An excellent way is to drill a small hole at the end of the butt



Location of Stop Waters in Single-Strapped Butt Joint

between the plates and plug with rivets for stop waters, as shown in the sketch. So far as I know, this is the only practical way of making single strapped butts watertight.

Fitting Deck Beam Knees

Q.—Can you tell me if it is the custom in general merchant construction to erect the deck beam knees as part of the deck beams or as part of the frames? SHIP FITTER.

A.—Deck beam knees are frequently riveted to the deck beams previous to the erection of the beams. The knees should be punched with two frame holes only in each in accordance with the requirements of the classification societies' rules, the others being left to be drilled in place. Sometimes the knees are riveted to the frame first and the choice between the methods seems to be the handiness with which the riveting can be done. When the knees are attached to the beams, they usually are included in the contract made with the beam squad, but when attached to the frames it usually requires an independent contract.

Correct Method of Counting Revolutions of Engine

Q.—I have had quite an argument with a brother engineer as to the proper way of counting the revolutions per minute of an engine under way. He holds his hand out and counts for a minute each time the crank touches his hand, beginning one, two, three, etc. I maintain that the first contact should not be counted and that he always gets one revolution per minute too many. Please tell me if I am right. DOG WATCH.

A.—You are right. An excellent way is to begin all counting with *zero*. This inaccuracy you mention is common and is often of appreciable importance in slow speed engines.

Effect of Varying Position of Compass on Board Ship

Q.—In discussing the steering qualities of vessels, one of my shipmates asserts that in ships where the pilot house (and steering gear) is placed forward or near the bow, the mariner's compass will respond slower to the turning of the ship, and consequently make the steering harder than it would be if the same compass and steering gear were placed in the after end near the stern. I contend that the movements of the compass would be identical whether it was placed near the bow, amidships or near the stern, neglecting, of course, any local attraction of the compass needle. Please decide who is right. H. W. S.

A.—You are right. The compass, aside from local attraction, is unaffected by variation in location aboard ship.

Formula for Estimating the Speed of a Boat

Q.—What must I know to tell how fast an engine will drive a boat without having seen the boat? I assume that I have all the information regarding the engine with the exception of the propeller.

I will appreciate greatly any assistance that you can give in regard to this subject, such as formulæ, etc. A. F. G., Jr.

A.—If the boat is not of the hydroplane type the following formula gives a fair approximation to the speed to be expected. This was published in an excellent article on this subject in *Motor Boating* of October, 1912, by H. H. W. Keith, and a reference to this article is desirable. For more complete discussion see "Propellers," by C. H. Peabody.

$$M = \frac{C \sqrt[3]{L \times P}}{B}.$$

Where M = speed in miles per hour.
L = length over all (feet).
B = beam, extreme (feet).
P = brake horsepower of engine.
C = constant = 9.5, moderate speed type.
= 8.5, high speed type.

Limitations of Heavy Oil Engines

Q.—As a reader of INTERNATIONAL MARINE ENGINEERING, I have become very much interested in the articles on heavy oil engines and have often wondered why engines of this type are not tried out on automobiles. The question I would like to ask is, Is this type of engine practicable for automobiles, and, if so, why are the makers not making experiments in this line? L. L. M.

A.—Heavy oil engines are of the Diesel or semi-Diesel type and operate upon cycles which involve the compression of the air charge to such a pressure that the temperature becomes high enough to ignite the fuel charge. This

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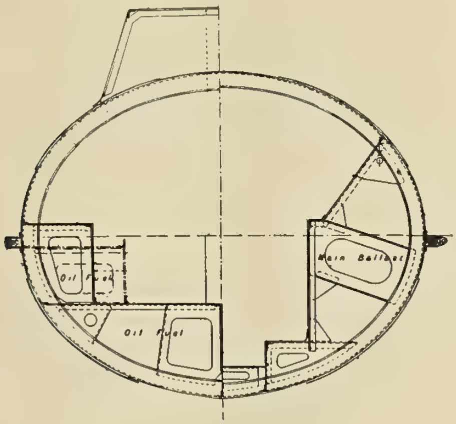
means added complication and weight to inject the fuel charge and perform other incidental operations so that the resultant engine is far too heavy to compete with the standard type of gasoline (petrol) engine for automobile work, and is also less simple.

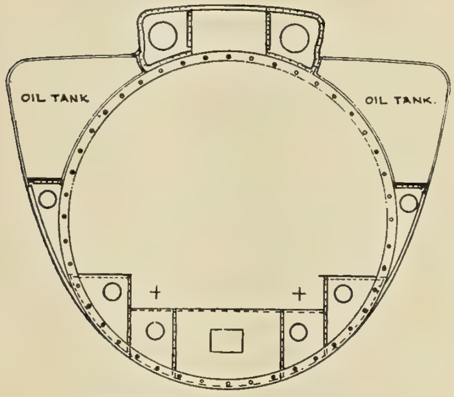
Submarines and Submersibles

Q.—Will pou please explain the difference between a submarine and a submersible? I see the terms used frequently in the papers and the activities of the two seem to be of the same sort. S. O.

A.—The line between the two types of under water vessels cannot be sharply drawn, but in general if the condition of operation which has received greatest attention in the design is the under water one, the vessel is classed as a submarine. If, however, the surface operation has been considered the more important condition, the result



Midship Section of Submarine



Midship Section of Submersible

is the submersible. Usually the submersible has a ship-shaped external form and the submarine a cigar-shaped form. The submersible has practically a submarine form (circular cross section) incased in a ship-shaped form for better surface operation (see sketches). The submersible usually has greater surface speed than the submarine, but a less submerged speed and shorter allowable period of submergence.

Operation of a Steam Gage

Q.—Will you kindly explain to me why the tube which actuates the hand of an ordinary steam gage tends to straighten out when the pressure goes on? Would it be possible to straighten out the tube completely if we applied sufficient pressure? P. T.

A.—The Bourdon tube of the common steam gage has a transverse section which becomes distorted when pressure is applied. The tubes are frequently elliptical in section, and when pressure is applied the transverse sections tend to become circular in shape. This action results in moving the walls of the tube, which are normal to the face of the gage, away from each other. As the lengths of the outer and inner arcs of the tubes as a whole cannot change, this separation of the arcs results in an increased radius of curvature of the tube as a whole, as may be seen by the following elementary discussion.

Assume a tube of elliptical cross section bent around the small diameter of the ellipse into the arc of a circle. Let the radii of the arcs of the walls be r_1 and r_2 for the no pressure condition and R_1 and R_2 when subjected to pressure. Let t be the small diameter of the ellipse before, and T this diameter after, pressure is applied; then

$$t = r_1 - r_2 \text{ and } T = R_1 - R_2$$

$$\frac{R_1 - R_2}{r_1 - r_2} = \frac{T}{t} \qquad (1)$$

The lengths of the arcs of the tube walls before pressure is applied are $K\,r_1$ and $K\,r_2$ for the outer and inner walls

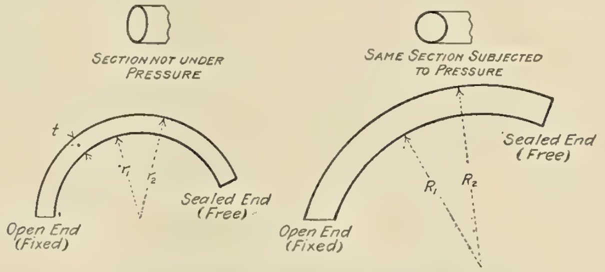


Diagram Showing Action of Bourdon Tube

respectively, where K is a constant. These lengths remain constant when pressure is applied, so that

$$K\,r_1 = K^1\,R_1 \text{ and } K\,r_2 = K^1\,R_2$$

Subtracting

$$K\,(r_1 - r_2) = K^1\,(R_1 - R_2)$$

and

$$\frac{K}{K^1} = \frac{R_1 - R_2}{r_1 - r_2} \qquad (2)$$

equating (1) and (2) we have

$$\frac{K}{K^1} = \frac{T}{t}$$

therefore

$$R_1 = \frac{K}{K^1}\,r_1 = \frac{T}{t}\,r_1$$

and

$$R_2 = \frac{K}{K^1}\,r_2 = \frac{T}{t}\,r_2$$

which means that the new radius of curvature of the tube as a whole is equal to the old radius multiplied by the ratio of the new over the old small diameter of the transverse section of the tube. The limit of straightening effect is reached when the transverse section becomes circular.

Position of Air Vent Cocks in Feed Water Heaters

Q.—Please tell me why the makers fit air vent cocks near the *bottom* of the steam space in feed water heaters. H. P.

A.—Saturated steam has a temperature corresponding to its pressure. If air is mixed with the steam, it has a temperature probably the same as that of the steam. For a given pressure and at the temperature corresponding to that of saturated steam, air has a greater density than steam (1.62 at 60 degrees and .25 pound absolute to 1.41 at 434 degrees and 358 pounds absolute), and therefore falls to the bottom of the steam space. Air is a good thermal insulator and its removal is very desirable to permit all tubes of the heater to do their proper work.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

The First Electrically Propelled Submarine Vessel

In the article on "Submarines," by Mr. Simon Lake, in the July issue, reference is made to the electrically-propelled submarine vessel which I invented, built and demonstrated at Liverpool in 1886. As only meagre details of this craft are given, I wish to call attention to the leading features of the vessel.

In the first place, what Mr. Lake terms down-haul screws *were not* used for submerging when under way, but were connected to a pendulum and were stationary so long as the boat was on an even keel, but were brought into action in connection with the after horizontal rudders when the boat deviated from a level plane, so as to bring it back automatically to an even keel. I then considered, and still consider, any deviation from an even keel dangerous when submerged. This, I think, has been proven, with unfortunate loss of life.

These propellers in vertical tubes could be used to submerge the vessel when stationary and in "awash trim." For submerging the vessel when underway I used a pair of horizontally balanced side rudders or inclinable water planes placed amidships. By regulating the angle of these the vessel was raised or lowered in the water. I never destroyed all the reserve buoyancy.

Two locomotive "fish" torpedoes were carried, one on each side above the side rudders, and secured to the vessel by grips which were operated by a lever inside the vessel, releasing the torpedo and starting its propelling power, so that it shot ahead of the vessel. This did away with the use of torpedo tubes and their complications.

This submarine was only 37 feet long, with a displacement of 15 tons, the intention being to carry it on board a war vessel and to work from that craft as a base. The accumulator, or electric storage cells, were to be recharged by the vessel's dynamos.

I claim to be the originator of the following features as applied to submerged vessels:

First.—That this was the first electrically propelled submarine vessel.

Second.—The use of horizontal balanced rudders placed amidships.

Third.—Vertical propellers in tubes through the vessel for keeping the vessel on an even keel or submerging when stationary.

Fourth.—The method of carrying and discharging "fish" torpedoes.

Fifth.—The adaptation of a submarine so that it could be carried by, and work from, a war vessel or other craft as its base.

With regard to Mr. Lake's statement, that I did not further develop submarines, I had produced a practicable submarine, *the first* to be propelled by electrical power derived from accumulator cells, which all recent submarines have copied. In fact, a Government inspector of submarines recently told me that I had in 1886 used various appliances that are now the cherished patents of various submarine companies. As stated by Mr. Lake, no government (except the Turkish) actually purchased any submarines until many years after I first brought mine to their notice. In the meantime I had become disgusted and left the field open to those who, with more capital, could make money by improving upon the inventions of others.

Riverton, N. J. J. F. Waddington.

Accident to a Condenser

While the engineer of a menhaden fishing steamer was getting ready to turn the engines over at the dock a peculiar and unusual accident occurred to the condenser. The engines were of the fore and aft compound type, with surface condenser built in as part of the frame. The air pump was independent, of the simplex type, and had been running for a short time previous to the accident. It stopped of its own accord and no one noticed the stoppage for some time, during which interval steam was blowing through the cylinder of the air pump into the condenser, into which the centrifugal circulating pump was also exhausting.

When the engineer discovered that the air pump was not running he went below and started it, then returned to the upper grating and opened the throttle on the reversing ram. Instantly there was a loud report, and on going below the back side of the shell of the condenser was found badly cracked in several places. These cracks extended almost the entire length of the condenser, one at the bottom, one at the center, and one near the top, with smaller cracks radiating from these. The throttle valve on the engines was tightly closed and the stop valve on the boiler merely cracked off the seat, with the steam-pipe drain open to the bilge, so that there could not have been any steam pressure in the condenser.

The only plausible explanation of this accident was that while the air pump was stopped water accumulated in the condenser from the condensation of the steam that was blowing through the cylinder of the air pump, also of the exhaust steam from the circulating pump. When the engineer opened the throttle of the reversing ram the air pump had not exhausted the condenser and the sudden inrush of steam from the reversing ram caused water hammer, which cracked the cast iron shell of the condenser.

It was at first thought it would be necessary to replace the damaged condenser with a new one, but this would have entailed considerable expense, it being necessary to take out the entire engine, with the exception of the bedplate and crank-shaft, as well as removing part of the deck house, in order to get the old condenser out and the new one in. There would also have been a delay of from six weeks to two months, a matter of serious importance, the fishing season being short, and it was finally decided to repair the old condenser by patching it.

The tubes and tube sheets were removed and two patches, made of 3/8-inch boiler plate, fitted on the inside of the condenser, covering the entire back side and flanged on top and bottom. These patches were fitted

after the broken parts were forced back into place, joined with red lead putty, and riveted on, care being taken that rivets were placed along both sides of all cracks to insure the patches being drawn tightly to the cracked places. The repairs were completed in ten days, and the condenser was absolutely tight under test and fully as strong as it was originally.

Had this condenser been fitted with a relief valve—one which would close with vacuum in the condenser and open when water accumulated—this accident could not have occurred.

New London, Conn. J. S.

Duplex Pumps

In a previous article (December, 1912) in this journal the writer dealt with setting the valves and testing this type of pump. He is still convinced from subsequent experience that this auxiliary is abused more from ignorance than from any defect in the pump itself. A duplex pump does not profess to shift water at a minimum of cost except under water works conditions—i. e., watertube boilers, triple expansion steam ends, Corliss valves and the refinements possible to a large and costly plant.

The ordinary duplex pump, however, is probably the cheapest form of water shifter extant. The capital cost per unit, say 100,000 gallons, pumped is lower. It starts, even if in poor condition, by the simple opening of steam to the pump. Pumping is, of course, "collar" work all the time; it is a dead steady load with no easing up. In addition, the duplex occupies less space for its capacity than any other form of reciprocating pump, rarely requires priming, and will actually pump water when in a shape and repair that would put most others out of commission. It may not be exactly the most economical, but has advantages which give it a wide application where economy is not an absolute consideration of prime importance, it is to be found working in a most satisfactory manner under the charge of inexpert labor.

The inventor of the Willans engine, one of the prettiest prime movers ever built, used to say that he preferred a gardener to an engineer to run an electric light plant having his engine. The gardener would be satisfied to open the stop valve, and so long as the job went round never interfered with its interior economy. The engineer, on the other hand, would display the curiosity inherent to his craft and would, in attempting to make adjustments and by dismantling and overhauling, put the engine out of commission. The duplex pump is another case in which the same remarks can apply with sufficient truth to make them "hits." The makers of this type of pump, without exception, put each pump made on the test bed, run them under steam and adjust them to give the best results. The engineer into whose hands a new duplex comes has only to pack the glands and connect up water and steam. Often, not satisfied with these simple matters, he opens up the pump and, from curiosity, experiments, to the undoing of the pump.

Some mechanical appliances, unless duly set and this to a nicety, will refuse duty altogether. The duplex pump, however, struggles gamely on under very adverse conditions, only expiring under protest if the injury is very severe. One mistake so common as to be almost universal is to allow no lost motion when setting the valves. Another is, in a vain attempt to get increased delivery, to pack the water pistons too tightly.

Having previously dealt with the setting of the valves and testing of a duplex pump, it has occurred to me that some further information on the subject of locating trouble when experienced with the duplex pump would prove helpful.

The following is in no sense a recapitulation of the previous article, but should be read in connection therewith, although, of course, it in no sense depends upon it.

Testing Pumps

A steam pressure gage must be fitted to the steam chest cover and a water pressure gage with regulating cock on the delivery side of pump, also a stop valve is needed to the delivery pipe from pump. The covers of both ends are usually provided with screwed holes for lubricators (which, by the way, are rarely in evidence, although supplied in every instance to a new pump).

In testing a boiler feed pump with everything in order and with steam pressure of, say, 40 pounds, it should be possible to obtain a full bore delivery pipe when delivering against an equal water pressure. The pressure on the water end gage is obtained by the regulation of the stop valve, and the discharge of water should be visible. With equal steam and water pressures the gage pointer on the water gage should be reasonably steady.

If the supply of water stops while the pump is running, it can usually be traced to the fact that the water pistons or plungers are letting by, or else that suction valves are leaky.

If the pump works erratically and the gage pointer shows violent pulsations the trouble may be traced to one or more leaky suction valves.

To Test for Leakage Through the Water Valves

Throttle down the delivery stop valve until the pump is running six to eight double strokes per minute. Care must be taken that the water pressure does not exceed what the casting is designed for (in boiler feed pumps this is usually 160 pounds). Adjust the steam valve to keep water within safe limits. Watch carefully each stroke; if one of the water pistons travels suddenly to the end of the cylinder, the suction valve on that end will most probably be the leaky one, the reason being that the water, instead of being forced through delivery valves against pressure, takes the line of least resistance through the leaky suction valve.

Other Causes of Erratic Working

(*a*) *Loose Water or Steam Piston.*—Loose pistons cause erratic behavior and bad knocking. Carefully check so that piston rod nuts tighten on to pistons and do not be misled by tight nuts.

(*b*) *Broken Joint Beneath Force Plate.*—This would cause gage fluctuations similar to those caused by leaky suction valves. This is a very common fault.

(*c*) *Broken Steam Cylinder Cover Joint Between the Two Steam Cylinders.*—This allows steam to be on back of both steam pistons at the same time, causing erratic working and slowing up of pumps, another very common trouble. In making new joints take care that the material is not too hard (ordinary millboard makes good water joints) and see that bolt holes are a good fit to the bolts. Take care in force plate and steam cylinder head joints that the castings are not hollow, and that the divisions between the cylinders in the case of steam cylinder head joints and the divisions between the valve chambers in the case of force plate joints are of ample width.

To Investigate a Troublesome Pump

When starting, carefully check the water pressure before doing anything else. It is not uncommon that the

boiler feed pipe, either inside or just outside the boiler, is "furred up." This "furring up" may reduce the area of the pipe sufficiently to throw excessive pressure on the water end against which pump cannot drive with sufficient speed to deliver enough water.

Duplex pumps and pumps in general fitted for boiler feeding are frequently blamed when the trouble exists in the piping and connections.

Another source of trouble is a *throttled suction pipe*, caused in some instances by lining up. This gives a decided cushioning effect on the pistons at one or both ends of the stroke.

A further cause having a like effect would be a *throttled exhaust*. To determine this note the number of strokes per minute before disturbing connections, and again with exhaust open to atmosphere; if a gain in speed is obtained, the trouble is in the exhaust pipe and not in the pump. Should, however, the trouble be in the pump, the cause should be looked for in the exhaust port of the slide valve, which will be found not to travel central across the exhaust ports and cylinder, causing back pressure on exhaust side of steam pistons.

Leaky Steam Piston Rings

These would also cause the pistons to be cushioned. To ascertain whether piston rings are steam tight, throttle down water pressure to slow up speed of pump. Then open up each drain cock on the cylinders in turn and watch carefully that there is a clean cut-off with the steam. If not, it shows that leakage is taking place either by the steam piston rings or else the slide valve.

Steam Piston Rings

These should be a free floating fit between the steam piston body and the follower.

Fitting New Steam Piston Rings to Cylinders

With the piston on the rod and ring in position, work the piston along the cylinders several times sharply; an examination of the ring will then show whether they have an efficient bearing.

To Test the Cylinder Bore

Place the steam piston ring only in the middle of the cylinder with its joint at the bottom. It should not be possible to pass a 4/1000 inch feeler between the ring and wall of the cylinder at any point.

Water Valves

These should be a free fit on the valve guard stem. There should be at least 1/16 inch clearance between valve and valve guard stem to insure that lime or sediment which forms on them shall not interfere with the free lift of valve. See that the center and outside faces are both perfectly flat with one another. If the center face is hollow, leakage takes place between the valve and stem.

Valve Seats

See that these are perfectly flat, and also that the top thread in center of seat is cut away. Otherwise the top thread may be pulled out when guard is screwed home and prevent the valve seating properly. In old pumps examine the outside of seat for corrosion. This would possibly lead to loose valve seat unless precautions are taken.

Slide Valves

This should be carefully checked. The length should just cover the ports. There is neither external nor internal lap. See that exhaust, cushion and steam ports are in a line with one another. See that valve port in valve is of correct length, and that it works centrally over the ports in cylinder, otherwise a throttled exhaust and consequent loss of speed will result.

Water Pistons

Make sure that these are not too slack in the liners. They should not be more than 1/16 inch small, otherwise trouble, especially in the smaller sizes of pumps, may arise, due to washing out of packing. In the fitting of packing to the water pistons measure the packing space available, measure packing before using, and allow 1/16 inch for the packing to expand sidewise. If necessary, reduce the size of packing by stripping layers to obtain this result. Also do not let the ends of turns of packing butt; ⅛ inch should be allowed for expansion in this direction. See that packing is not too tight a fit internally and externally. To render hard packing pliable it can be softened by soaking in boiling water for a few minutes.

Piston Rods

Both steam and water pistons should be tried on rods before being placed in the pump. See that the tapers on the rods are a good fit to the pistons. Make sure that there is sufficient thread on the piston rods, that the nuts shall properly jam home on the follower. Make certain that the nuts are not too tight, as it is difficult to ascertain when in the pump cylinder whether the nuts bed properly on the pistons.

Levers and Spools

The jaws of spools must be machined or filed out perfectly square with one another and the lever must be a perfect rolling fit at any portion of the stroke. See that the end of lever is perfectly circular and that edges are quite square. A defective fitting lever results in the spool twisting out of position. A loose lever results in shocks to the valve gear and speedily causes slack motion pins and links.

The foregoing fairly exhausts the usual and some of the unusual faults and troubles incidental to the duplex pump. Some of the hints and dont's may seem unnecessary and trivial, but each is the result of special experience and all have value.

Beyond mentioning the duplex pump in a casual way, no text-book, it is believed, devotes very much attention to the subject. Certainly nothing known to the writer gives any hints as to the usual troubles experienced.

Hard cases may make bad law, but locating trouble in a mechanical sense provides good experience. To the engineer economy is not merely an incidental item, but is the prime factor in his existence. Auxiliary machinery runs away with more coal than is usually credited, while the condition and upkeep of these minor steam users can be, and should be, studied.

It is hoped that sufficient material is here set forth, together with the former article, to show how to locate and eliminate most of the difficulties and also to provide for complete overhauling of the pumps in question with certainty and ease.

London. A. L. Haas.

Tank Ship Sebastian Equipped with Werkspoor Engines.—The two 800 brake horsepower, two-cycle Diesel engines, installed on the tank ship *Sebastian* when she was built, have been removed because of their unsatisfactory working and are being replaced with Werkspoor four-cycle Diesel engines.

Canadian Shipbuilding.—During 1914 a total of 43,346 tons of shipping was built in Canada, the largest annual output from this country in fourteen years.

Marine Articles in the Engineering Press

Problems Relating to Ship and Machinery Design—Model Experiments for Stability of Submarines—Lubrication of Journal Bearings

Destruction of German and Austrian Ships in Antwerp.—An account is given of the damage by explosions to German and Austrian shipping caught by the European war in the harbor of Antwerp. The hulls of the vessels were little damaged, only one ship being sunk, but of the thirty-six steamers, twenty-eight had their machinery damaged. The damage is stated to be almost exclusively in the cylinders, piping, main stop valves and columns, produced by cartridges hung to the outside of the parts. The damage is quite considerable, but the German author expresses surprise that the explosives were not applied internally in the engines and also in the boilers, due probably to the haste of evacuation of the fortress. 2 illustrations. 2,900 words.—*Zeitschrift des Vereines Deutscher Ingenieure,* May 8.

Calculation of the Top Girder of a Suction Dredge.—The author discusses the problem of how to proportion the top girder on the centerline of the ship which by chains holds the bottom doors of the hopper compartments of a suction dredge. He considers the case as one of a longitudinal girder, supported upon two rigid end bulkheads and upon seven elastic and flexible transverse beams. The method employed is stated to be a graphical one as proposed by Ritter and described for bridges. It is also considered valuable for shipbuilding calculations, where many similar problems present themselves. Its principle is to find for every beam and for every piece of a beam the elastic weight and the limit of elasticity. The author carries through the calculations necessary for the completion of the graphical diagram, describing all the steps taken for an actual case with a top girder about 53 feet long. 6 illustrations. 4,600 words.—*Schiffbau,* June 9.

A Basis for Rational Design of Heat Transfer Apparatus.—By E. E. Wilson. The results of tests of heat transfer apparatus have been so inconsistent that the formulation of rational basis for design has been precluded. This lack of agreement leads to the conclusion that some variable has been neglected, and a study of the results of tests on feed-water heaters and condensers leads to the belief that this variable is the viscosity of the circulating water. Since the accepted law for heat transfer is of the same general form as that for the resistance to flow in pipes, it seems likely that there is some close relation. It also seems probable that the effect of viscosity is of the same general character in each case, and on this assumption the published results for heat transfer are corrected in the same manner as are the results of Osborne Reynolds' work on the resistance in pipes to flow of water through them. With this correction the results are reconciled, not only in an individual case, but for different experimentors as well. If, now, these results as corrected are put in the form of resistances to heat transfer, a linear relation is found to exist between the resistance and the reciprocal of the water velocity. The correction for viscosity may be put in this same form as a function of temperature. The resistance may then be evaluated in terms of its component parts and reduced to the form of an equivalent film of water of known thickness. These linear expressions may now be incorporated in a form giving the area of the heating surface required to transmit a given quantity of heat under the given flow conditions, in a condenser or feed water heater. This expression seems rational in form and applicable throughout the range of practice, and in addition it seems possible through the use of the relations established to determine by experiment a similar expression for the resistance to heat transfer in other types of apparatus. 10 illustrations. 8,500 words.—*Transactions of the American Society of Mechanical Engineers,* June.

U. S. S. Balch: Contract Trial Performance.—By Henderson B. Gregory. The *Balch* is one of the eight destroyers authorized by Congress March 4, 1911, and is a sister ship of the *Aylwin, Parker* and *Benham,* all four vessels being built under contract by William Cramp & Sons Ship & Engine Company, Philadelphia, Pa., at a price of $756,100 (£155,000) each. The *Balch* is a twin screw vessel fitted with a combination of Cramp-Zoelly turbines and reciprocating engines, one of each on each shaft developing altogether 16,000 shaft horsepower and designed to give the vessel a speed of 29.5 knots at about 1,036 tons displacement. For speeds of 17 knots and above the turbines alone are used, and for the lower cruising speeds reciprocating engines are used in combination with the turbines. Steam is supplied by four oil-burning White-Forster watertube boilers arranged in pairs in two separate compartments. The hull is 300 feet long on the waterline and 30 feet 4 inches beam at the waterline, with a draft of 9 feet 2½ inches to the load waterline. The block coefficient is .415. The trial data obtained on her official trials are given in tabulated form, and also revolutions, speed and power curves are plotted. At the highest speed, the contract speed of 29.5 knots was slightly exceeded, but the fuel oil consumption was in excess of that guaranteed. 1 illustration. 3,000 words.—*Journal of the American Society of Naval Engineers,* May.

On the Laws of Lubrication of Journal Bearings.—By M. D. Hersey. In order to establish a rational basis for bearing design, it would be desirable to have empirical equations, or curves, showing accurately and completely how the friction loss and load-carrying power of bearings depend on all the physical conditions governing the action of lubrication, including, of course, the size, shape and fit of the bearing, the speed, degree of lubrication, properties of the lubricant, and characteristics of the cooling system. The problem of mapping out the laws of lubrication in this general way, whether by piecing together existing data or by making new experiments, is such a complicated one that it is worth while to stop and consider whether any general principles are available which may serve to simplify it. A recognition of the above facts has led to the present paper, the object of which is first to reduce the problem to a physical basis by suitable definitions and restrictions, and then to develop certain general relations which will simplify the solution of the problem. These relations are of two sorts and may be summarized as follows:

a. The general forms of the laws of lubrication are deduced by dimensional reasoning, and the properties of dynamically similar bearings are discussed.

b. A distinction is pointed out between the "characteristic"—i. e., purely dynamical equations—and the "working" equations needed in the final design of a bearing. It is then shown that the dynamical characteristics of the bearing, and the thermal characteristics of the lubricant

and the cooling system are three independent parts of the problem which may be separately investigated, thus greatly diminishing the number of combinations of conditions needed for mapping out the laws of lubrication over the full range of all the variables involved. Finally, a general method has been outlined for deducing the desired working equations by utilizing the results of these three investigations.

The paper closes with an analysis of the "ideal bearing"—i. e., one which is perfectly circular in cross section, etc. In this connection Sommerfeld's results are reproduced in a convenient form for practical use, and extended by a treatment of heating effects. While intended primarily as a particular illustration of the foregoing general relations, the equations and curves of the ideal bearing doubtless afford a first approximation to the laws of lubrication of actual bearings. 9 illustrations. 12,800 words.—*Transactions of the American Society of Mechanical Engineers,* June.

Influence of Disk Friction on Turbine Pump Design.—By F. zur Nedden. The mathematical survey of the problem leads to these conditions for a minimum loss through disk friction: (*a*) Smoothness (polish) of both disk and casing. Roughness of either is equally detrimental. (*b*) Smallest possible surface of both. Excessive extension of surface is equally detrimental whether it is the surface of the disk or of the casing. (*c*) Outward indication of attainment of minimum is the fact that the waste water rotates half as fast as impeller. A gyrostatic pressure is generated by the rotation of the waste water and added to static pressure prevailing at the center of the impeller. From the influence of the width of the impeller it follows that it is important to keep the thickness of metal at the periphery as small as possible. Protruding rims are objectionable. The influence of the ordinary roughness of non-machined castings has no perceptible effect on the efficiency except with high lift pumps. Painting or japanning the surfaces generally seems less desirable than machining them with a medium heavy cut. High polish seems wasted. The experiments verify conclusions of mathematical survey. The influence of viscosity is proportional to its fifth root; yet it is responsible for an improvement in the efficiency of hot water turbine pumps. The effect of pumping heavy oil and tarry liquid is estimated. The influence of fluid density is almost exactly proportional to the specific gravity. The loss through disk friction constitutes a constant percentage of the normal useful power at all speeds in one and the same pump. Generally its percentic value grows with the value of $\frac{\text{head per stage}}{\text{capacity}}$ at constant speed, and diminishes with increasing speed and constant ratio $\frac{\text{head per stage}}{\text{capacity}}$. High heads are more economically produced by high speeds or a greater number of stages than by increasing the diameter of the impellers, but the number of stages should be left to the discretion of the makers, not fixed by specifications. A steep angle between impeller blades and the tangent at the periphery serves very considerably to improve the efficiency owing to indirect reduction in disk friction losses, especially in high lift pumps. The disk friction reaches a minimum for a certain width of the waste water chamber, which is about 3/8 inch for disks of 12 inches diameter. The increase with increasing width is due: (*a*) To the increase in retarding surface. (*b*) To the induction of secondary or induced hydraulic currents. Concentric ribs are advantageous, radial ribs are detrimental. In single-stage pumps the rotation of the waste water reduces the tendency for leakage by about 20 to 35 percent. In multistage pumps the same influence may even increase the leakage. Inequality in shape or roughness of the waste water chambers on both sides of the impellers produce a gyrostatic axial thrust due to disk friction which can assume very considerable values. The direction of this thrust is indicated by the rule: "The impeller is drawn to the side where the waste water rotates fastest." 12 illustrations. 18,000 words.—*Transactions of the American Society of Mechanical Engineers,* June.

Experimental Methods of the German Government Model Tank, Berlin.—To fully determine all the factors of resistance of a model ship, the author considers it desirable to make runs with the bare hull without propeller, aside from those of the hull with the propeller and from those with the propeller independently of the hull. There is given a full list of the denominations used and of the formulas employed for the final values. In the first two chapters the runs are carried through for a small 4,325-ton cruiser, and the results tabulated as well as the principal final values, illustrated in diagrams. In the second chapter of runs of hull with propeller are also entered the factors which race-augment and wake-gain have upon the propulsive coefficient. In the third chapter examples are given for tugs or vessels loaded by towing pulls; in one case for a single screw vessel with three different towing pulls, and correspondingly also for a twin screw vessel. 14 diagrams, 5 tables. 6,400 words.—*Schiffbau,* May 12 and 26.

The Surface Condenser (Modern Theory and Practice).—By C. F. Braun. The importance of the surface condenser in modern steam power plants warrants more careful consideration of design than is usually given. The functions of a surface condenser are to reduce the back pressure on the prime mover, return to the boiler the water of condensation as a chemically pure feed, return to the cycle as many heat units as possible, and remove from the feed water air in solution. The four separate fluids handled should approach conditions as follows: Steam should distribute in the condenser with minimum friction, be reduced to minimum temperature, and be converted into water for easy removal. Air, a slow conductor of heat, should be cleared from heating surfaces, freed from water vapor, and reduced to minimum temperature. Condensate should be cleared from heating surfaces, freed from air, and delivered at maximum temperature. Circulating water should pass with minimum friction, deposit minimum scale, and absorb maximum heat. The main factor effecting these results is heat transfer through the surface, which is proportional to the logarithmic mean temperature difference. The resistance to heat transfer may be divided into that on water side of tube, that of tube, and that on steam side of tube. If analyzed in this manner, Orrok's results previously published show straight line relation between heat transfer from water to tube to velocity according to following equation:

$$U_w = 245 + 141\,V.$$

Attention in design should be given to all of these factors, and a comprehensive rating should include the following: (*a*) Quantity of steam condensed, (*b*) vacuum obtainable (corrected to 30 inches barometer), (*c*) temperature available cooling water, (*d*) cooling water exit temperature, (*e*) condition of air at point of removal, (*f*) friction head on cooling water, (*g*) temperature of condensate at point of removal. 17 illustrations. 8,000 words.—*Transactions of the American Society of Mechanical Engineers,* June.

New Books for the Marine Engineer's Library

Practical Guides to Board of Trade Examinations for Marine Engineers' Certificates—Data Regarding Northern Pacific Ports

Elementaries, Verbals and Drawing for Marine Engineers. (Part II of Griffin's new Guide to the Board of Trade Examinations for First and Second-Class Engineers.) By R. A. McMillan, B. Sc., Wh. Ex. Size, 5½ by 8½ inches. Pages, 323. 300 illustrations. London, 1914: Charles Griffin & Company, Ltd. Philadelphia, 1914: J. B. Lippincott Company. Price, $3.00 net.

The primary object of this book is to provide instruction which will enable marine engineers to pass the Board of Trade examinations for second and first class engineers' certificates. There are many engineers who have not had the opportunity of gaining any experience in the working and management of refrigerating machinery, steam turbines or oil engines, and others who have only an imperfect knowledge of the use of the indicator, indicator diagrams and the adjustment of slide valves. A working knowledge of such matters cannot be acquired wholly from books, but, with the aid of a good book on such subjects and some practical experience, an engineer will find that he can accomplish much more and become more efficient in handling marine machinery with results which are likely to lead to his further advancement.

The book includes sections on the slide valve, the indicator and indicator cards, the marine steam turbine, electric lighting, refrigerating machinery and oil motors. Over 100 pages of elementary questions for first and second class engineers are given, together with complete answers to the questions. About 25 other pages contain verbal questions and answers on marine boilers, indicator cards, shafting, propellers, condensers, pumps, the slide valve, etc. Thirty drawings of marine engineering details, such as are required at Board of Trade examinations, are also given, together with instructions for answering the questions commonly asked in connection with the drawings.

The book is a thoroughly practical guide for those who are taking up the profession of marine engineering, and will be found a most useful aid for advancement in this profession. In recent years there has been a steady increase in the amount of scientific knowledge required of seagoing engineers, and new inventions and developments are continually changing the nature of the work for which chief engineers on board ship are responsible. Under such conditions the fundamentals must be thoroughly understood, and for acquiring such knowledge this book will be found very useful.

The Marine Motor. By Frank W. Sterling. Size, 4½ by 7 inches. Pages, 136. Illustrations, 52. New York, 1915: Outing Publishing Company. Price, 70 cents net.

To the novice who is unfamiliar with the construction and operation of marine gasoline (petrol) engines, this book will prove a valuable aid in overcoming difficulties in mastering the details of a marine motor and in operating it successfully.

Naval Recognition Book. By Fred T. Jane. Size, 5 by 7¼ inches. Pages, 63. Numerous illustrations. London, 1914: Sampson, Low, Marston Company, Ltd. Price, 1 shilling net.

In Jane's "Fighting Ships" several pages are devoted to silhouettes of typical naval vessels, so that by reference to these silhouettes the ships can be identified at a distance at sea. In this volume silhouettes are given of representative ships in each class of naval vessels in the British navy. A complete list of the vessels in the British navy is given, with particulars as to tonnage, speed and armament. The book is of handy pocket size and should prove a convenient aid for navigators at sea.

Practical Mathematics for Young Engineers. By E. Hovenden. Size, 5 by 7½ inches. Pages, 144. Illustrations, 25. Glasgow, 1914: James Munro & Company, Ltd. New York, 1914: D. Van Nostrand & Company. Price, $1.00 net.

From his work as principal of the Marine Engineers' Training College, Cardiff, the author is thoroughly acquainted with the requirements of practical draftsmen and mechanics, and for such men the contents of the book have been specially arranged to form a sound groundwork for the special knowledge necessary to obtain a Board of Trade certificate as a marine engineer. Many of the examples given in the book are taken from Board of Trade examination papers. The book covers the practical application of mathematics to simple problems in mechanics.

Mechanics for Marine Engineers. By A. N. Somerscales. Size, 4½ by 7¼ inches. Pages, 277. Glasgow, 1914: James Munro & Company, Ltd.; New York, 1914: D. Van Nostrand & Company. Price, $1.50 net.

The subject matter in this book comprises a series of lessons in mechanics for marine engineers and engineering students, treated arithmetically, with numerous diagrams. Each lesson is first fully explained; then the rules applying to the particular lesson are given with examples worked out showing complete calculations for solving the problems. Finally, at the end of each lesson problems are given, together with the answers, but without the calculations, leaving it to the student to apply the knowledge gained in studying the lesson for the solution of the problems.

Terminal Facilities of North Pacific Ports. Size, 5 by 6¾ inches. Pages, 336. Seattle, Wash., 1914: Terminal Publishing Company. Price, $2 net.

Regulations covering the principal ports of the North Pacific from San Diego on the south to Nome on the north, together with the charges that are assessed against either ships or cargoes, are given in full in this book, together with the names and addresses of government officials, foreign consuls and others whose names and addresses are of value to masters and shippers. One section is devoted to the depth of water in all the bays and inlets on the United States Coast, and customs, marine insurance and immigration regulations are set forth in detail. The book is designed as an annual publication and covers very thoroughly the terminal facilities of the North Pacific ports of the United States.

Business Administration. By Edward D. Jones. Size, 5 by 7½ inches. Pages, 275. New York, 1914: The Engineering Magazine Company. Price, $2.

By a study of the older professions of war, statecraft and science, Professor Jones has sought to establish the scientific principles of the newer profession of the administration of maufacturing and operating companies. From the data compiled in this study definite primary principles of administration have been analyzed. The administrator is considered as a leader of men more than as a trustee of properties. No special doctrine or practice of management is advanced, but the treatment of the subject tends to bring administration to the high plane occupied by the older professions and serves to stimulate and direct the ideas of those who have made this profession their life-work.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

The most successful company in the United States operating vessels in the trans-oceanic trade, and owning probably more such vessels than any other company—we refer to the Standard Oil Company—shows its confidence in the future of the American merchant marine by having under contract four extra large tank steamships with the New York Shipbuilding Company and three with the Newport News Shipbuilding & Dry Dock Company. The tonnage of tank steamships now under construction or contract in the seacoast shipyards amounts to over 200,000 tons, of which vessels aggregating 88,000 tons are for the Standard Oil Company.

Shipbuilding is apparently the only branch of engineering on the Atlantic Coast that is running 100 percent capacity without a trace of so-called war orders. What is more important, there is every assurance that this 100 percent capacity will continue for at least five years to come.

There has probably been no time in the history of the world when so many vessels were in need of repairs as at the present. The requisitioning of dry-dock facilities in Europe for naval purposes is driving mercantile shipping to this country for repair work, with the result that never before have the dry-dock companies of America enjoyed such a rush of business.

Recent Orders for New Ships

The New York Shipbuilding Company, Camden, N. J., has received a contract from the Gulf Refining Company, Pittsburgh, Pa., for two oil-tank steamships, one of very large size and the other of medium size.

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has received a contract from the Munson Steamship Line, New York, to build a steamship to cost about $400,000 (£82,000).

The Welin Marine Equipment Company, Long Island City, N. Y., has received a contract from the Quartermasters Department, U. S. Army, Washington, D. C., to build twelve Lundin motor lifeboats of the housed-in type, each 30 feet long.

Percy & Small, Bath, Me., are about to lay the keel for a large schooner.

The Merritt & Chapman Derrick & Wrecking Company, New York, will have a steel derrick lighter built, to be about 135 feet long.

The Union Iron Works, San Francisco, Cal., has received a contract from the Union Oil Company, San Francisco, to build an oil tank steamer to cost about $1,000,000 (£205,000).

The Fore River Shipbuilding Corporation, Quincy, Mass., has received a contract from the Luckenbach Steamship Company, New York, to build a steamship to be about 450 feet long.

The Baltimore Dry Dock & Shipbuilding Company, has received a contract from the Trans-Atlantic Motor Ship Company, Ltd., Christiania, Norway, to build two large schooners to be equipped with Bolinders oil engines.

The Newport News Shipbuilding & Dry Dock Company has received a contract from the marine department of the Standard Oil Company, New York, to repair its steamer *Standard*, which was recently damaged by fire.

The American Shipbuilding Company, Cleveland, Ohio, has received a contract to cut in two four steamers of the Erie Railroad Great Lakes fleet before transfer to the purchaser, the Staten Island Shipbuilding Company, Port Richmond, N. Y. The contract price for the work is about $60,000 (£12,300).

The Fore River Shipbuilding Corporation, Quincy, Mass., has received a contract to build a 750-ton submarine for the Spanish government.

The Elco Company, Bayonne, N. J., are building 500 70-foot launches for the British government, and it is reported that the Standard Motor Construction Company, of Bayonne, N. J., will build the 8-cylinder motors of 380 horsepower required for these launches, at a contract price stated to be $5,000,000 (£1,025,000).

Shipbuilding Contracts Pending

The Ocean Steamship Company (Savannah Line), New York, opened bids recently for two ships, but it is understood that contracts have not yet been placed.

It is stated that Libby, McNeil & Libby, Honolulu, T. H., intend to build a vessel of about 1,500 tons, equipped with Diesel engines, to ply between San Francisco and the Hawaiian Islands.

The Bureau of Lighthouses, Washington, D. C., will soon advertise for bids for constructing the lighthouse tender *Palmetto,* 90 feet long, to have for motive power two gasoline (petrol) engines of 65 horsepower each.

Bids for the New Coast and Geodetic Survey vessel will be opened at the office of the Coast & Geodetic Survey, Washington, D. C., on August 10.

It is announced in the newspapers that Henry Ford, of Detroit, will enter the ore and freight carrying business on the Great Lakes. If this is true, Mr. Ford will doubtless be in the market for steamships.

According to report, J. P. Morgan & Co., of New York, together with other capitalists, are planning important development works in Alaska. When these works are carried out the necessary result will be the building of several steamships. In fact, shipyards have already received inquiries regarding vessels suitable for Pacific States-Alaska traffic.

New Steamship Companies Organized

The Inland Navigation Company has been incorporated in the State of Delaware with a capital stock of $9,000,000 (£1,845,000) to engage in the transportation of passengers and freight on the rivers, canals and lakes of the United States. One of the principal incorporators is said to be John H. Bernhard, 52 Broadway, New York.

The Marine Transport Service Corporation has been organized with offices at 17 Battery place, New York, and, it is stated, will shortly begin the operation of three separate lines of freight steamers.

One of the new lines is to run from New York through the Panama Canal to Los Angeles, San Francisco, Portland, Tacoma and Seattle. The second is to be operated from New York to South American ports and the third line is to operate to miscellaneous foreign ports, whenever business offers.

For the first line from New York to Tacoma, the company has already chartered the freighters *Eureka* and *Tampico,* belonging to the Pacific Steamship Company. In addition, the company is now conducting negotiations for the purchase of four additional steamers.

New Shipbuilding Companies Incorporated—Expansion of Existing Shipyards

The Galveston Dry Dock & Construction Company, Galveston, Texas, has been organized and has applied to the City Commission for a lease of 600 feet of frontage as a site for a marine railway, dry docking and shipbuilding plant. It guarantees to expend $100,000 (£20,000) within two years and $150,000 (£30,750) within five years, if the lease is granted.

The James Tregarthen & Sons Company, New Hamburg, N. Y., has been incorporated with a capital stock of $50,000 (£10,250) for the purpose of building vessels. The incorporators are J. Tregarthen, J. A. Tregarthen and W. H. Tregarthen, all of Brooklyn, N. Y.

The Fore River Shipbuilding Corporation, Quincy, Mass., is receiving bids for 2,500 tons of steel for extensions to its machine shops in order that its capacity to build ships may meet the demand.

The New London Ship & Engine Company, Croton, Conn., has just let a contract for a five-story building 106 feet by 135 feet to increase the capacity of its plant, and is probably in the market for machinery.

The Lake Submarine Company, Bridgeport, Conn., has bought some adjoining land and will at least double its capacity for building submarine boats.

The Island Transportation Company, Stockton, Cal., is planning to construct a shipyard to cost about $50,000 (£10,250).

It is announced that the Clooney Construction & Towing Company, Lockport, La., has resumed work with a force of 100 men, and it is stated that the company has sufficient work on hand to keep its plant operating for a long time to come.

It has been formally announced that the Newport News Shipbuilding & Dry Dock Company, of Newport News, and the New York Shipbuilding Company, of Camden, N. J., will go into the business of building submarines. These firms have asked the Secretary of the Navy to have the advertised opening of bids on Aug. 2 for 16 submarines, authorized by the last Congress, postponed, in order that they may submit bids.

The California Shipbuilding Company, Augusta, Me., has been incorporated in the State of Maine with a capital of $5,000,000 (£1,025,000) to engage in the manufacture of, and to deal in, all kinds of vessels and equipments.

Marine Terminal Projects

Immense water-front improvements in the meadow district of Newark, N. J., are being made, under the direction of the Board of Street and Water Commissioners of that city. Most of the dredging has been started, and work is beginning on docks having a frontage of 4,500 feet, with piers, bulkheads, etc. The docks are to be equipped with cranes and various kinds of freight-handling machinery. Railroad connections will be made with the several roads entering the city. $2,000,000 (£410,000) has already been authorized by the New Jersey Legislature for this work. Morris R. Sherrerd is the chief engineer and James J. Hallock is the engineer in charge of the work.

According to press reports, bids will soon be called for by the Department of Wharves, Docks and Ferries, Philadelphia, Pa., for the construction of the first of the ten municipal piers to be known as the Moyamensing Piers, which, when completed, will cost about $1,500,000 (£307,-500). The whole group, with the machinery required, will involve an expenditure of almost $25,000,000 (£5,-125,000).

H. McL. Harding, consulting engineer, New York, has been authorized by the Wharf & Dock Commission, Beaumont, Texas, to prepare working plans for the first wharf and terminal improvements, including the construction of an 800-foot shed and the installation of several loading and unloading cranes and other machinery. The estimated cost is $109,000 (£22,400).

Ford, Bacon & Davis, New Orleans, La., have drawn plans and specifications for a large cotton warehouse and terminal in the city of New Orleans, to cost about $3,000,-000 (£615,000). It is reported that the contract will soon be let. This terminal is to be equipped with the latest mechanical appliances for handling cotton as well as other freight.

The Pennsylvania Railroad Company, Philadelphia, Pa., is stated to be asking bids on a dock 942 feet long by 66 feet wide. Included in the equipment will be a considerable amount of coal-handling machinery.

S. M. Kearns, 625 West Ocean avenue, Long Beach, Cal., has been awarded a contract by the Board of Public Works of Long Beach to build the Belmont Pier. John Schulz, Wright & Callender building, Los Angeles, is engineer.

Emil Schacht & Son, architects, Portland, Ore., are preparing plans for Albert Brothers, Portland, for the construction of a dock and warehouse on the Willamette River. The estimated cost is $20,000 (£4,100).

Bids will be received by the Superintendent of Public Works, State of New York, at Albany, N. Y., until August 17 for terminal contracts Nos. 37 and 46 of the New York State Barge Canal.

Plans are being prepared by the Department of Public Works, Quebec, P. Q., for improving the city docks at a cost of $500,000 (£102,500).

The city of Pascagoula, Miss., has voted to spend $17,000 (£3,500) for the purpose of constructing public wharves or docks.

The city of Augusta, Ga., is receiving bids for the construction of a reinforced concrete pier and warehouse.

The California State Board of Harbor Commissioners is having plans prepared for the construction of Pier No. 11 at San Francisco.

W. P. Seaver, Inc., Grand Central Terminal, New York, has received a contract to build the 30th Street Pier at Brooklyn, N. Y., at a cost of $196,263 (£40,250).

J. A. McEachern Company, Inc., Seattle, Wash., has received a contract from the Shell Oil Company, Portland, Ore., for the construction of a dock on the Portland River front.

Henry Steers, Inc., New York, has received a contract for the construction of a new pier at the foot of 29th street, South Brooklyn, N. Y., at a cost of $116,148 (£23,800).

George B. Spearin, New York, has received a contract to build a pier at the foot of 35th street, South Brooklyn, N. Y., at a cost of $309,201 (£63,500).

Bids have been received by the Board of Trustees of Redmondo, Cal., for the construction of a reinforced concrete pier to cost about $121,000 (£24,800). George W. Harding, Los Angeles, is the engineer.

The General Chemical Company, New York, is planning to build a pier at Marcus Hook, Pa.

Progress of U. S. Naval Vessels

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of naval vessels for the United States navy:

BATTLEESHIPS

	Ton.	Knots.		Feb. 1.	July 1.
Nevada	28,000	20½	Fore River Shipbuilding Co...	86.4	94.2
Oklahoma ...	28,000	20½	New York Shipbuilding Co..	87.2	96.6
Pennsylvania.	31,400	21	Newport News Shipbldg Co...	67.1	81.5
Arizona	31,400	21	Navy Yard, New York......	48.1	66.8
Mississippi ..	32,000	21	Newport News Shipbldg. Co..	6.0	23.4
Idaho	32,000	21	New York Shipbuilding Co...	9.9	32.1

TORPEDO BOAT DESTROYERS

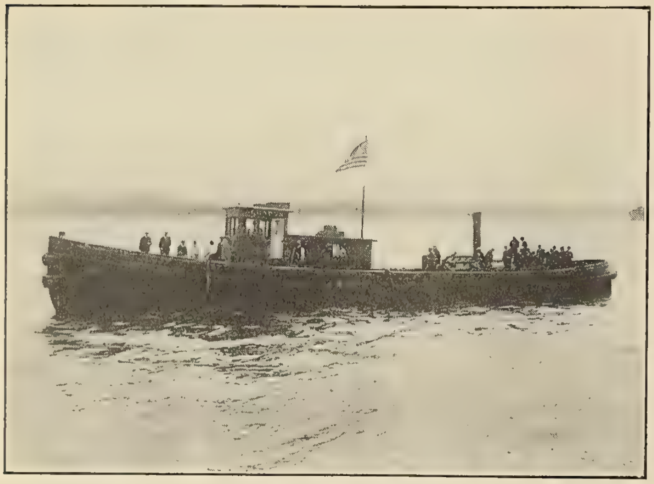
	Ton.	Knots.		Feb. 1.	July 1.
Downes	1,010	29	New York Shipbuilding Co...	99.2	100.0
O'Brien	1,050	29	Wm. Cramp & Sons.........	93.3	100.0
Nicholson ..	1,050	29	Wm. Cramp & Sons.........	90.2	100.0
Winslow	1,050	29	Wm. Cramp & Sons.........	87.0	95.9
Cushing	1,050	29	Fore River Shipbuilding Co...	84.0	98.1
Ericsson ...	1,050	29	New York Shipbuilding Co...	92.8	99.5
Tucker	1,090	29½	Fore River Shipbuilding Co...	33.2	76.3
Conyngham .	1,090	29½	Wm. Cramp & Sons.........	54.3	78.3
Porter	1,090	29½	Wm. Cramp & Sons.........	50.8	72.5
Wadsworth .	1,090	29½	Bath Iron Works............	78.6	97.8
Jacob Jones..	1,090	29½	New York Shipbuilding Co...	52.2	80.7
Wainwright .	1,090	29½	New York Shipbuilding Co...	51.7	80.2
No. 63	1,090	29½	Fore River Shipbuilding Co...	6.4	29.2
No. 64......	1,090	29½	Fore River Shipbuilding Co...	6.4	28.6
No. 65......	1,090	29½	Bath Iron Works............	0.0	24.0
No. 66......	1,090	29½	Bath Iron Works............	0.0	22.6
No. 67......	1,090	29½	Wm. Cramp & Sons.........	0.0	13.1
No. 68......	1,090	29½	Navy Yard, Mare Island.....	0.0	4.0

SUBMARINE TORPEDO BOATS

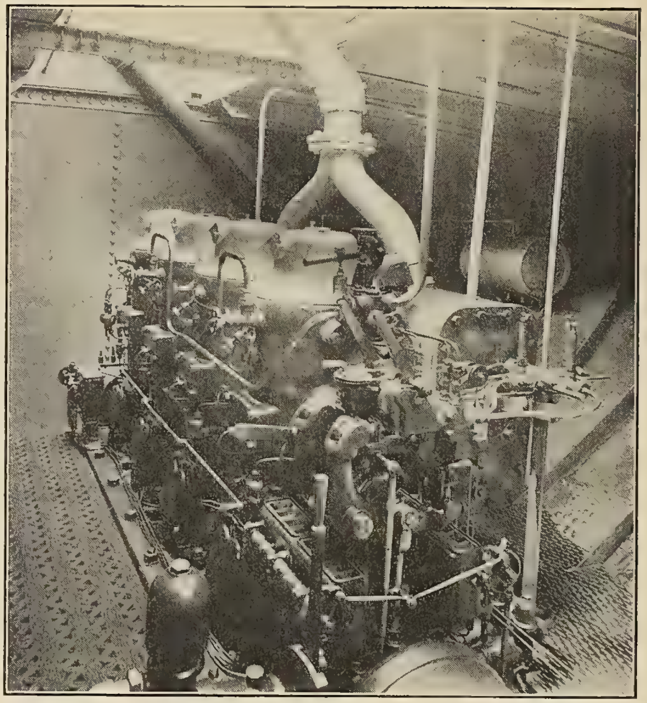
				Feb. 1.	July 1.
G-2	....	....	Navy Yard, New York.......	89.7	89.7
G-3	....	....	Navy Yard, New York.......	86.7	88.6
L-1	....	....	Fore River Shipbuilding Co...	89.6	98.3
L-2	....	....	Fore River Shipbuilding Co...	84.6	98.4
L-3	....	....	Fore River Shipbuilding Co...	75.5	92.7
L-4	....	....	Fore River Shipbuilding Co..	76.0	91.9
L-5	....	....	Lake T. B. Co..............	58.2	72.4
L-6	....	....	Craig Shipbuilding Co.......	52.7	63.4
L-7	....	....	Craig Shipbuilding Co........	51.6	61.7
M-1	....	....	Fore River Shipbuilding Co...	63.4	78.8
L-8	....	....	Navy Yard, Portsmouth.....	3.0	38.7
L-9	....	....	Fore River Shipbuilding Co...	50.0	73.1
L-10	....	....	Fore River Shipbuilding Co...	45.6	71.0
L-11	....	....	Fore River Shipbuilding Co...	3.2	62.0
N-4	....	....	Lake T. B. Co..............	0.0	24.7
N-5	....	....	Lake T. B. Co..............	0.0	24.1
N-6	....	....	Lake T. B. Co..............	0.0	23.5
N-7	....	....	Lake T. B. Co..............	0.0	23.4

Contract Let for Big Lumber Schooner Fitted With Auxiliary Engines

C. R. McCormick, head of the McCormick Lumber Company, San Francisco, Cal., recently placed a contract with the St. Helens Shipyard, St. Helens, Ore., for a five-masted wooden schooner 265 feet long equipped with two Bolinders engines aggregating 640 horsepower. The vessel will have a capacity of over 2,000,000 feet of lumber and will cost $125,000 (£25,600). The beam will be 46 feet, the depth of hold 19 feet and the gross tonnage between 1,700 and 1,900 tons. With her auxiliary engine power she will have a speed of about 7 knots. Provision is made for carrying 800 barrels of fuel oil, which will give the vessel an operating radius of 60 days.



Water Boat *Aquadon*



Engine Room of the *Aquadon*

For handling the cargo a double set of winches will be installed, the gear being similar to that adopted on steam lumber schooners. With this machinery it is estimated that over 400,000 feet of lumber can be loaded per day, enabling the ship to take on a full cargo in five days. To facilitate loading bow and stern ports will be provided for handling long lengths of timber.

Water Boat Aquadon Fitted With Bolinders Oil Engine

The Boston Provision & Ship Supply Company, of New York, owners of the water boat *Aquadon,* which is operated in New York harbor for carrying fresh water to harbor vessels, has recently fitted the *Aquadon* with a 100 brake horsepower, four-cylinder, direct-reversible Bolinders fuel oil engine, designed to give the vessel a speed of about 8 knots light and 7 knots loaded, with a guaranteed consumption of fuel oil of .63 pound per horsepower hour. In the engine room are four cylindrical tanks, one on the starboard side forward, 16 inches diameter by 30 inches long, with a connection to the water injection pumps on the main engine, and a filling pipe from the fresh-water service pumps. On the starboard side aft is a fuel service tank 16 inches diameter by 36 inches long with connections to the fuel injection pumps on the main engine arranged to be filled by a pump drawing from the main fuel storage tank, which is located in the extreme after end of the boat. On the port side aft is a compressed air tank, 12 inches diameter by 5 feet long, used for storing air at 120 pounds per square inch for starting the engine. On the port side forward is a tank also 12 inches diameter and 5 feet long, used as a whistle tank. As such, it is connected to the starting tank and also to the recharging valve on the after cylinder of the engine.

The exhaust gases from the engines are carried from the silencers up into a funnel, the top of which is 12 feet above the deck. The hull of the vessel, which is 102 feet long, 22 feet beam and 8 feet 6 inches depth, is divided into five compartments by four watertight bulkheads. The forward compartment is the general locker, the second and third are water tanks with a total capacity of 160 tons for carrying fresh water, the fourth is the engine room and the after compartment a storage tank for fuel oil.

The water service pump for the rapid handling of the cargo of fresh water is situated on the starboard side of the engine room and is driven by a belt from the main engine.

Yacht Southwark Equipped with South-wark-Harris Valveless Oil Engine

A 4-cylinder, 240-indicated horsepower Southwark-Harris oil engine (described on page 390 of our September, 1914, issue) has just been installed in the yacht *Southwark,* owned by C. P. Vauclain, of Philadelphia. The yacht is 98 feet long overall by 16 feet beam and 7 feet draft. On her initial trial trip she made a speed of about 10 miles per hour against the tide and a head wind, with the engine turning at 225 revolutions per minute. On a run of 35 miles, from Philadelphia to Chester, Pa., and return on June 26 twenty-nine gallons of Mexican oil at an approximate fuel cost of less than 75 cents (3/1½) was used, the time for the run being 3 hours 20 minutes. The engine is manufactured by the Southwark Foundry & Machine Company, Philadelphia, and is designed to give the vessel a speed of 12 miles per hour, using 7½ gallons of fuel per hour, at a cost of 18¾ cents (0/9¼) per hour. The capacity of the fuel tanks is 1,400 gallons, giving the yacht a cruising radius of 2,200 miles.

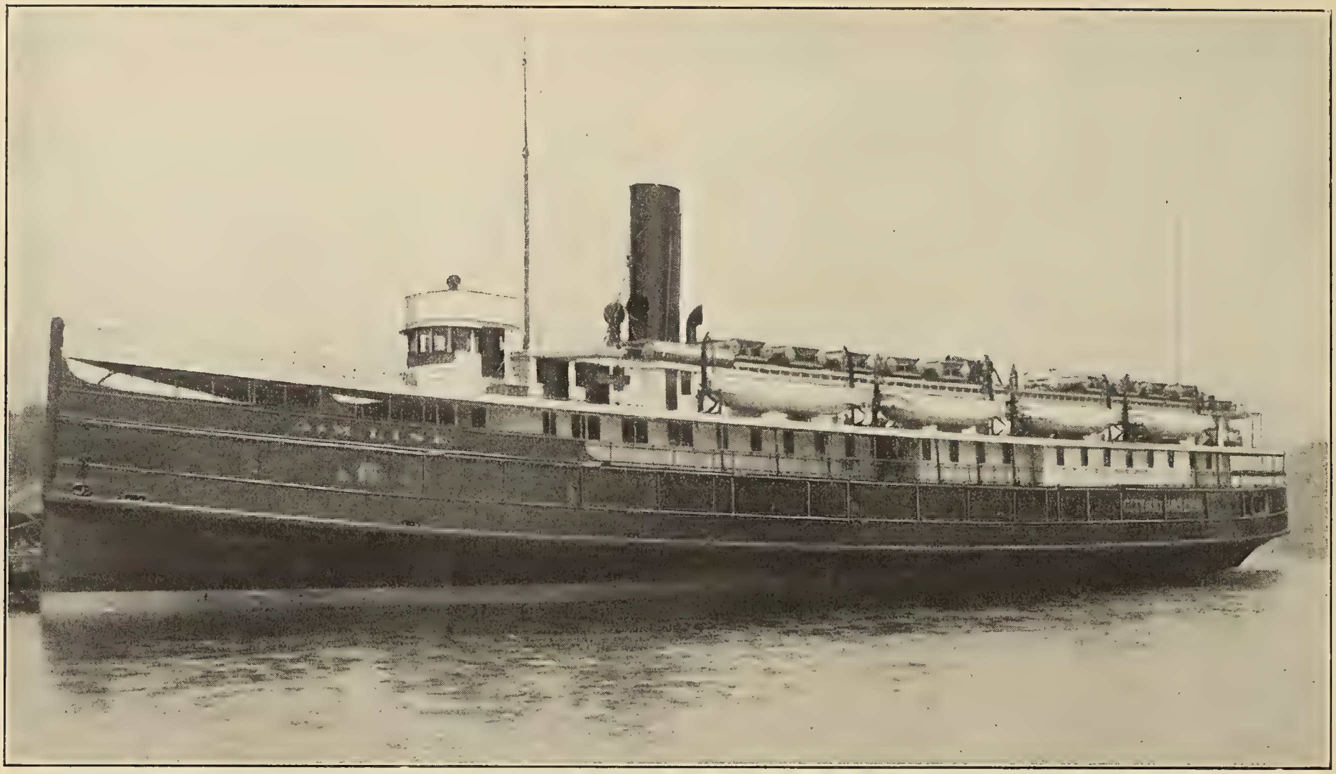
Yacht *Southwark*, the First Vessel to be Equipped With a Southwark-Harris Oil Engine

Trial Trip of the Motor Ship San Francisco

The official trial trip of the motor ship *San Francisco,* built by Burmeister & Wain, Copenhagen, for the Rederiaktiebolaget Nordstjernan, Stockholm, was carried out in Copenhagen Sound on June 12. The *San Francisco* is a sister ship of four others already completed for the same company, having the following dimensions: Length between perpendiculars, 362 feet; beam, 51 feet 3 inches; depth from awning deck, 34 feet; deadweight capacity, 6,550 tons. Propulsion is by twin screws actuated by two four-stroke, single-acting engines, each having six cylinders capable of developing 2,000 indicated horsepower continuously under normal load, giving the ship a speed of 10 knots. The ship is further equipped with two auxiliary engines each developing 200 brake horsepower, which drive the air pumps and dynamos for working all the auxiliary machinery, including the steering gear, and supplying current for electric light. All the cargo winches are also electrically driven. The auxiliary Diesel engines are in duplicate, each being of sufficient capacity so that it can supply all the needs while the other is standing by as a "spare."

During the trial trip the vessel attained a speed of 10.62 knots with the engines developing 1,885 indicated horsepower at 151 revolutions per minute. The consumption of fuel oil averaged 58.61 pounds per hour with the engines developing 1,863 indicated horsepower, giving a consumption of .315 pound of fuel oil per indicated horsepower hour of the main engines, including the consumption for all the auxiliary machinery. As the mechanical efficiency of the main engines has been determined in the testing shops of the builders to be .85, the consumption per brake horsepower of the main engines works out at .37 pound. The fuel used was Solar oil.

The owners of the *San Francisco* have placed an order with Burmeister & Wain for four additional motor ships, making in all ten motor ships in this company's fleet.



Graham & Morton Transportation Company's Steamer *City of St. Joseph,* Fitted with New Life-saving Equipment

Lake Steamer Fully Equipped with Lundin Lifeboats and Welin Davits

The freight and passenger steamer *City of St. Joseph,* of the Graham & Morton Transportation Company, Chicago, Ill., has recently been equipped with life-saving apparatus in accordance with the latest United States laws conforming to the requirements prescribed at the recent International Conference on Safety of Life at Sea at London. The equipment includes eight 24-foot, 40-person Lundin standard steel lifeboats and fifteen 25-person Lundin life rafts. The boats are of the open-type, each boat being placed under a separate set of Welin quadrant davits.

Welin Davits and Lundin Lifeboats on the *City of St. Joseph*

Among the principal advantages of this type of lifeboat is the fact that although they are self-bailing, they have four or five times the tank capacity required by the new rules. They are also fitted with balsa wood fenders, which not only prevent damage to the boat in smashing against the side of the ship, but also add to the buoyancy and stability of the boat. The manufacturers claim that such boats will in emergency take care of twice their capacity without endangering their stability or buoyancy. Provision is made as far as possible for the safe launching of the boats when the vessel is either upright or listed by using the Welin davits, but if for any reason the boats cannot be launched by the davits they can be cut loose and depended upon to float off the deck if the vessel sinks, thereby making the full lifeboat equipment available for rescue work.

Recent Launchings

The steel hull for the ferryboat *Fort Lee,* a screw boat 200 feet long, 40 feet beam, molded, and 65 feet beam over guards, was launched by the Harlan & Hollingsworth Corporation, Wilmington, Del., on June 29. The vessel is being constructed for the Public Service Corporation of New Jersey, the machinery being supplied by W. & A. Fletcher & Co., of Hoboken, N. J.

The dipper dredge *Cascadas,* designed by the Bucyrus Company, South Milwaukee, Wis., for the United States government for use on the Panama Canal, was launched in the yards of the New York Shipbuilding Company, Camden, N. J., June 26. The dredge is equipped with double-tandem compound engines, 16 inches and 28 inches diameter, with a stroke of 24 inches, designed to exert a maximum pull on the hoisting rope of 235,000 pounds. This is said to be the largest and most powerful dipper dredge in the world.

The torpedo destroyer *Conyngham,* one of the six destroyers authorized in the last naval appropriation, was launched at the yards of the William Cramp & Sons' Ship & Engine Building Company, Philadelphia, Pa., July 8. She will have a speed of 29½ knots.

ENGINEERING SPECIALTIES

Marten-Freeman Compensating Davit

The problem of proper and efficient handling of lifeboats is now receiving considerable attention, owing to the new legislation which has, in effect, condemned the old system of round-bar davits and which requires the installation of a suitable mechanical device to insure the best possible results from the lifeboat equipment in time of need. "Best possible results" means the positive ability to get all lifeboats overside in the shortest possible time and with the least amount of effort, all to be capable of accomplishment under severe conditions. As positive action and general efficiency are the requirements of a mechanical davit, the following description of the Marten-Freeman compensating davit is of interest.

Marine engineers have frequently stated that the ideal davit would be one involving a minimum of sliding or rubbing friction with rolling friction substituted therefor under the main loads and stresses—i.e., a so-called track and trolley system, as, under these conditions, the theoretical power required to displace the boat from the inboard to the outboard position would be at a minimum. The Marten-Freeman compensating davit might be termed a track and trolley davit, inasmuch as that system is used for carrying the moving loads. The fundamental principle involved in the device, however, is apart from the track and trolley.

The davit consists of a cast steel frame forming a track and supports, a steel trolley of the tandem roller type, which rolls along the track and carries the steel boom at its fulcrum, the compensating link and the bronze actuating screw and crank. The screw engages a bronze nut which "floats" in the trolley in such a manner, it is claimed, that a deflection in the frame, climatic change, or obstruction on the track cannot cause the screw to bind, there being sufficient freedom in all directions. The flanged tandem rollers are designed to distribute the load over the track and render tilting of the trolley frame impossible. The track is narrow, and it appears impossible to impede the operation of the davit by foreign matter on the track, as the rollers are small, the track smooth, and any obstruction is readily pushed or sheared off. It is quite obvious that it would take tremendous resistance from ice, other foreign matter, or loose gear to obstruct the action of the link. Another feature affecting the element of safety is that the compensating link forms an unbroken mechanical connection at the inner end of the boom at all stages of the operation. The boom is so constructed that it forks over the frame and screw, thus tending to keep all stresses set up within the davit along a centerline, and the boom is firmly supported at its foot. The bronze actuating screw is amply protected from injury by a steel tee and all bearings are of non-corrosive metals.

The seat of the mechanical principle is in the compensating link which connects the foot of the boom to a fixed center at the base of the frame, and the functions of this link, with its differential compensating action, are clearly illustrated in the accompanying diagram, which shows the relative positions of the boom and link when the fulcrum is advanced through uniform intervals. It also shows the differential and compensating action of the link, which results in greatly reduced thrust on the screw and accounts for the comparatively small amount of power required to operate the davit. The diagram also indicates the direction (not the magnitude) of the resultant force due to a vertical load at the boom head and assuming that the screw is removed. The thrust along the screw is equal to the horizontal component of that force. Therefore the nearer vertical the resultant force is maintained the less the stress along the screw, and the less the operating power required for any given moment.

The theoretical direction of the resultant force for any given position is obtained by a line drawn through the fulcrum to the point of intersection of a vertical line through the boom head and a line drawn through the link centers. When the boom is vertical there is no overturning moment, the resultant force is vertical and there is no thrust on the actuating screw. In this position the link is almost horizontal, assumes no load, and

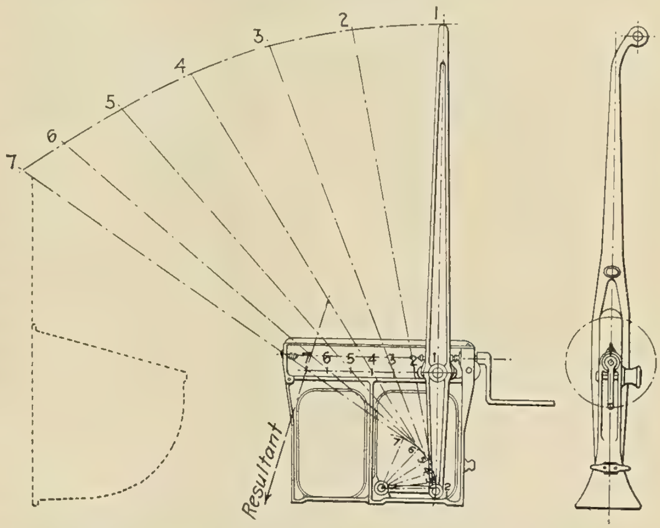


Fig. 1.—Diagram Illustrating the Principle and Action of the Marten-Freeman Compensating Davit

does not affect the direction of the resultant force. As the boom is extended the overturning moment of the load increases, but during this action the link comes immediately to a position to assume tension and to act as a partial counter to the overturning moment of the load. During the early stages of movement from the vertical the overturning moment is small, due to the slight angularity of the boom. As the operation proceeds, however, the angularity of the boom increases, and the moment

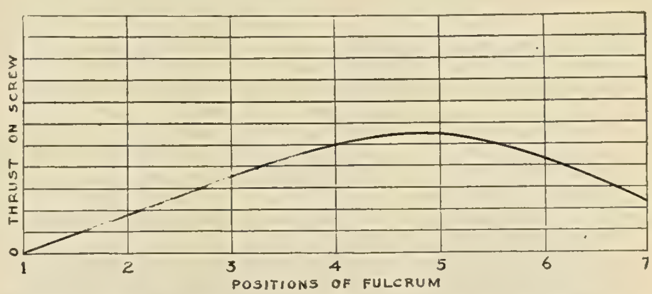


Fig. 2.—Curve Showing Variation in Thrust on the Screw Due to the Compensating Action of the Link

increases in consequence; but it is seen from the diagram that, for uniform intervals of advance of the fulcrum, the increase in the angularity of the boom (and consequently the increase in the overturning moment) is lessened in ratio. At the same time the link is brought more and more rapidly toward the vertical and, in consequence, is acting more and more as a counter to the overturning moment, thus keeping the thrust on the screw at a minimum, and consequently the effort required to operate the

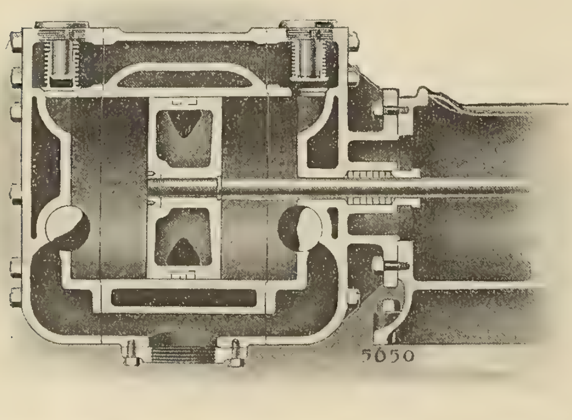
davit is correspondingly small. When a point slightly beyond mid-position is reached the counter effect of the link, due to its differential action, increases more rapidly than does the overturning moment, due to the increasing angularity of the boom, and from that point on the thrust on the screw is rapidly reduced.

The curve in Fig. 2 illustrates the variation in the thrust on the screw assuming a dead load at the boom head, and it is apparent from this curve that the thrust is at a minimum in both extreme inboard and outboard positions, thus allowing the available power to be used in overcoming the inertia of the load in starting either inboard or outboard. The davit is so proportioned, and the centers so located, that the maximum thrust on the screw is relatively low, which accounts for the ease and rapidity with which lifeboats under this system can be launched. The curve further shows that with this system greater outreach can be obtained without increasing the length of the boom, inasmuch as the angularity of the boom in the outboard position can be increased without increasing the thrust on the screw. As a matter of fact, this can be accomplished with an actual further reduction in the stresses along the screw. The system throughout tends toward equilibrium, and the effort required in launching the boat is in proportion to the condition of equilibrium maintained. The diagram also shows the path of travel of the boom head, and it will be noted that this line becomes flatter as the boom is extended and as the link approaches a vertical position the amount of drop of the boom head is decreased in proportion to its extension.

This davit is manufactured in a number of sizes and types designed to meet all possible conditions for the proper and efficient launching of lifeboats with safety and in the least possible time, and the mechanical principle involved in its construction is such that it lends itself admirably to meet satisfactorily many unusual conditions in the handling of such equipment. This device is being marketed by C. J. Hale, 17 Battery place, New York.

Palmetto Packing for Air Compressors

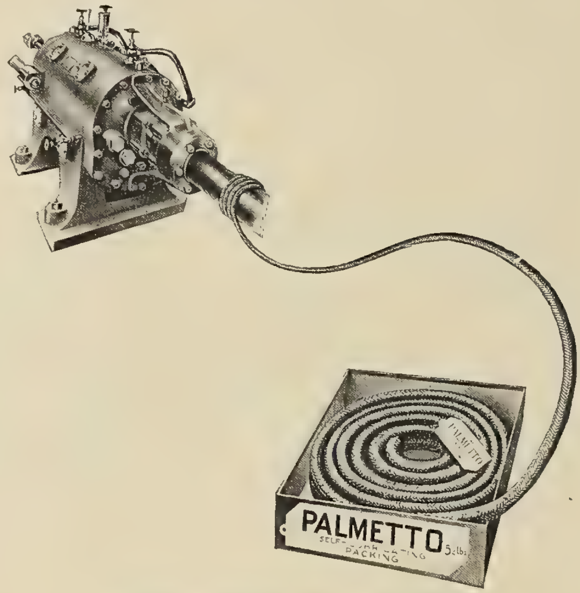
One of the difficulties commonly encountered in compressed-air plants is the leakage of air due to the deleterious effect of the high temperatures of compressed air on the packings commonly used in air compressors, air valves and line connections. The dry heat of compressed air causes packings made of vegetable matter to char and deteriorate. Asbestos packings usually used harden too quickly into a rock-like substance, which not only causes



Section Through Air Cylinder Showing Position of Packing

excessive wear on the rods upon which they work, but which also destroys their usefulness as packing and causes wasteful leaks.

Because of the heat conditions, a packing for compressed-air apparatus must not only be of mineral sub-



Palmetto Packing for Air Compressors

stance, but must remain soft and pliable in service. The "Palmetto" packing, manufactured by Greene, Tweed & Company, New York City, it is claimed, meets such conditions satisfactorily, because it is made of a mineral substance having great tensile strength and is kept from hardening by a special process whereby a compound of graphite grease is so injected into the center of each single strand of the packing that it separates the particles of asbestos and so prevents it from amalgamating back into the rock from which it was fiberized. In other words, the lubricant supplies the necessary moisture to overcome the heat-destroying tendency of compressed air.

On account of its materials and the peculiar process of its manufacture, "Palmetto" packing, it is claimed by the manufacturers, is peculiarly adapted for long service in compressed-air apparatus.

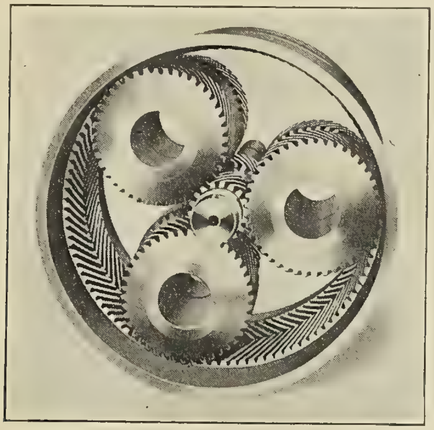
The Turbo-Gear

The Turbo-Gear Company, Baltimore, Md., has placed on the market a speed transformer which can be used either as a speed-reducing or speed-increasing gear. The gear consists of a large internal double helical gear, a double helical pinion and intermediate double helical gears. The slow-speed member, to which is secured the slow-speed shaft, is mounted on two heavy-duty ball bearings, one on each side of the gears, and supported directly by a heavy housing. With this arrangement the slow-speed member and the shaft carrying the intermediate gears and the high-speed shaft and pinion are independent of each other for support, and each is supported directly by the housing.

The high-speed shaft has a central passage through which oil is pumped, and a continuous stream of oil is sprayed on the gears through radial passages in the pinion. The high-speed bearings, besides having forced feed lubrication, are provided with oil rings and a good-sized oil reservoir for emergency use. It should be noted that the

gears do not run in oil but are being sprayed by a continuous stream of oil under pressure.

It is claimed that the turbo-gear has an efficiency of not less than 95 percent for any speed ratio and that it is especially suited for marine work, either for transmitting power from a high-speed turbine to a slow-speed

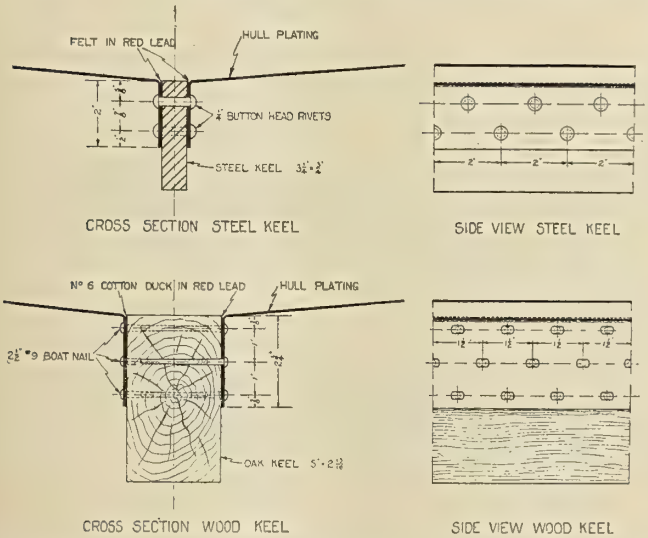


Turbo Gear

propeller, or in connection with various auxiliaries on board ship, such as high-speed electric motors for driving air compressors, refrigerating machinery, blowers, etc. At present the turbo-gear is built in one size only, which is capable of transmitting various powers up to 75 horsepower.

Advantages of Steel Keel for Metal Lifeboat

The advantage of building a metal lifeboat on a steel keel, rather than on a wooden keel, is explained by the



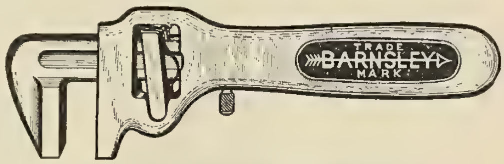
Sketches Showing Difference in Construction of Wooden and Steel Keel Metallic Lifeboat

Welin Marine Equipment Company, Long Island City, New York, as follows:

As is generally known, wood checks and warps, and for that reason it is extremely difficult to insure permanent tightness where the garboards are joined to the wooden keel. Besides, as shown by the drawing, there is the obvious danger that the nails, which extend through the garboards into, but not wholly through, the wooden keel, will pull out when the boat is heavily loaded, particularly when the excessive expansion and contraction of the wood, due to the elements, are considered, as compared to the steel. As regards lasting qualities, the difference in favor of the steel keel is very obvious when it is borne in mind that on account of the acid that the wood contains and also the possibility of leakage the plating will deteriorate very much quicker when the boat is built on a wood keel. With the steel keel there is a decided advantage over the construction of steel ships, the keel being made of rolled steel and the plating galvanized iron, which will considerably reduce the danger of rusting.

Barnsley Automatic Wrench

The Barnsley automatic wrench, manufactured by the Automatic Wrench Manufacturing Company, Inc., Boston, Mass., comprises only three parts—a jaw, handle and clutch. The automatic action of the wrench is brought about by an ingenious clutch arrangement. The clutch has a neutral position which allows the jaws to move freely in and out. To operate the wrench the object to

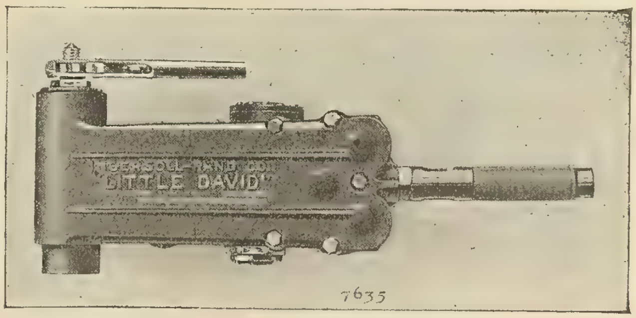


New Automatic Wrench

be turned is placed between the jaws and the jaw either pressed in or drawn in with a thumb trigger under the handle until the jaw strikes the object where it is locked by the clutch. The harder the pull on the wrench the tighter is the locking action. To open the jaws, or to release the jaws from the object, it is only necessary to exert a slight pressure on the clutch when the jaws spring open, or, closing the jaws together releases the clutch and the jaw is self-opening. The clutch is made in one piece and, it is claimed, is unaffected by oil or grease, making it impossible for the wrench to "freeze" on a nut. The wrench illustrated is 10 inches long when open, and fits nuts up to 1¾ inches. It is useful for any purpose where an ordinary monkey wrench is used.

A New "Little David" Drill

The "Little David" close-quarter drill illustrated, which is manufactured by the Ingersoll-Rand Company, New



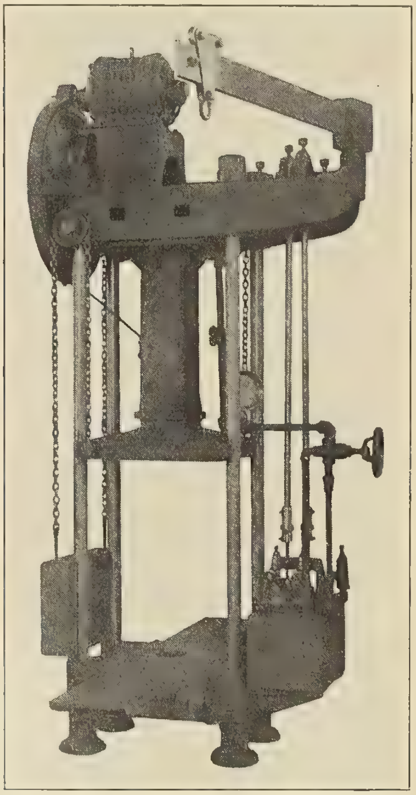
Close-Quarter Drill

York, is particularly adapted for working in cramped or confined positions where the regular type of four-piston, reciprocating, pneumatic drill cannot be used. The distance from the end of the casing to the center of the

spindle is only 1 5/16 inches. The motor is of a novel, three-cylinder design, and operates in a bath of oil. The valve is of the rotary type, gear-driven from the pinion of a three-way crank-shaft, which is operated by three ratcheted levers which directly connect the pistons to the drill spindle. It is claimed that there is practically no strain on the crank-shaft, as the power is transmitted direct from the pistons through the levers to the ratchet spindle. The fact that the spindle has a triple-ratchet, so that one of the ratchets is engaged on the spindle at all times, makes it possible to develop more power and maintain a much more constant pull on the spindle. The casing is divided in such a way that the loosening of a few cap screws allows easy access to all moving parts, and the manufacturers claim that the drill can be dismantled and completely reassembled in thirty minutes. The drill is fitted with a No. 4 Morse taper socket, is rated for drilling up to 3 inches and reaming and tapping to 2 inches, and operates at a speed of 150 revolutions per minute.

60-Ton Self-Contained Inverted Hydraulic Forcing Press

The hydraulic press illustrated is a new design of inverted hydraulic forcing press brought out by the Hydraulic Press Mfg. Co., Mount Gilead, Ohio. It is used as a general utility press for forcing work, and is a self-

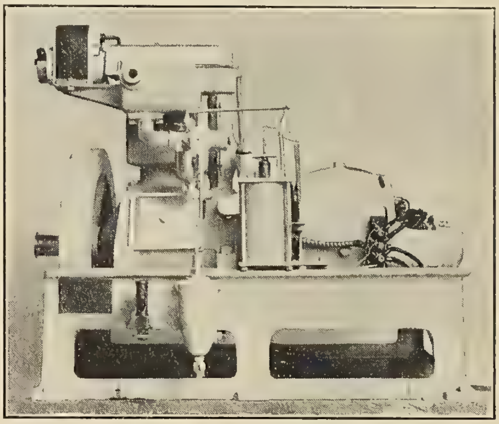


60-Ton Forcing Press

contained unit which requires no auxiliary water or power supply. It is driven either by an electric motor or by belt. The press is equipped with a two-plunger vertical hydraulic pump whose plungers are 5/8 inch in diameter and have a stroke of 3½ inches. This pump is driven through two eccentrics which are operated by a 3 horsepower motor mounted upon the press. The lower platen, which is close to the floor, has a pressing surface 24 inches by 22 inches, with a hole in the center 6 inches in diameter, to take the end of the hub or shaft during the pressing operation. The movable platen of the same size is guided in its travel by babbitted bearings on the strain rods. The ram is returned after the pressing operation by a weight.

Matthews Marine Lighting Sets

The Matthews Boat Company, Port Clinton, Ohio, well-known builders of motor boats, have placed on the market a light, compact and reliable electric-lighting set especially

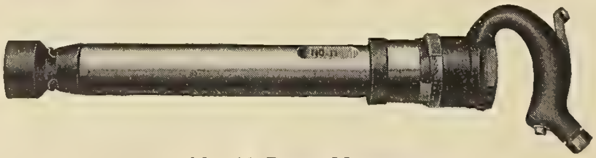


1-Kilowatt Lighting Set

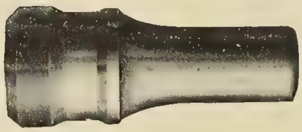
designed for pleasure and work boats and as auxiliary sets for steam vessels. The sets are made in sizes ranging from 1 to 2½ kilowatts capacity, the set illustrated being a 1-kilowatt plant capable of supplying current for fifty lights. The generator is direct connected to a single-cylinder gasoline (petrol) engine.

New Pneumatic Hammer

An improved form of the Boyer Hammer has just been placed on the market by the Chicago Pneumatic Tool Company, 1026 Fisher building, Chicago. This hammer, which is No. 11, has a piston diameter of 1 3/16 inches,



No. 11 Boyer Hammer



"Parker" Rivet Set

with a stroke of 11 inches and a capacity for putting down 1½-inch rivets. It strikes 700 blows per minute and weighs 31½ pounds. Owing to the extremely heavy blow of this hammer and the unusually severe blow it inflicts on the rivet sets, the so-called Parker set is used. The Parker set has a wide, tapering shoulder which, it is claimed, enables it better to absorb and withstand the effects of the heavy blows.

In common with the standard form of the Boyer hammer, this tool is divided into three distinct members—handle, cylinder and valve—which make for quick examination and economical upkeep and repairs.

PERSONAL MENTION

Operating Engineers

John McGraw, of Albany, N. Y., has been appointed chief engineer of the tug *Dr. David Kennedy.*

William Wells, of Albany, N. Y., has been appointed first assistant engineer of the tug *William H. Kinch.*

Frank Matte has resigned as chief engineer of the tug *George Van Tuil,* of the Cornell Steamboat Company.

Ambrose Van Wie, formerly chief engineer of the towboat *M. A. Knapp,* has accepted a position with the Cornell Steamboat Company on the tug *George Van Tuil.*

John Edward Burlingham has been appointed chief engineer of the fast freight steamer *Edward F. Murray,* of Albany, N. Y., which went into commission on July 12.

James La Coy, formerly first assistant engineer of the tug *Wm. H. Kinch,* has been appointed chief engineer of the steamer *M. A. Knapp,* of the Great Lakes Dredge & Dock Company.

Henry Lampman, of Albany, N. Y., formerly first assistant engineer of the steamer *M. A. Knapp,* has been appointed first assistant engineer of the freight steamer *Edward F. Murray.*

Frank Gosselin has been appointed chief engineer of the steamer *Mary Gordon,* of the Manhattan Navigation Company, which runs from Albany to Troy, N. Y. This steamer formerly ran from Mamaroneck to New York City.

John Pardee, of South Rondout, N. Y., chief engineer of the tug *W. B. McCollough,* which recently left Rondout for Albany, N. Y., was seriously injured on July 10 by having his leg caught in the shaft of the tug.

Naval Architects, Consulting Engineers and Shipyard Officials

Naval constructors William B. Ferguson, Jr., John E. Otterson and George S. Radford, of the United States Navy, have resigned to accept positions with private firms.

Andrew Fletcher, president of the W. & A. Fletcher Company, Hoboken, N. J., has been elected as one of the directors of the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., for the ensuing year.

Colonel J. C. Sanford, U.S.A., secretary and disbursing officer of the American section of the Permanent International Association of Navigation Congresses, has removed his office from the old Custom House, Detroit, Mich., to the Custom House, New Orleans, La.

James Adamson recently retired from the post of engineer superintendent of the British India Company's steamers at the Royal Albert Docks, London. After serving an apprenticeship in Glasgow and studying at Glasgow University, Mr. Adamson served for several years as draftsman for various shipbuilding and engineering companies, becoming a chief draftsman. After a few years of sea experience he became identified with the British India Company at the docks, acting as assistant and, for the last twenty years, as superintendent engineer. Mr. Adamson was one of the founders of the Institute of Marine Engineers, and has been its honorary secretary since the Institute was founded.

Supply Men

E. E. Baker, formerly New York representative of the Eckliff Automatic Boiler Circulator Company, of Detroit, Mich., has been transferred to the Detroit office of this company.

G. W. Williamson, Jr., formerly of the American Engineering Company, Philadelphia, Pa., has opened an office in the Singer building, New York City, to handle several marine specialties, among which is the Eckliff automatic boiler circulator manufactured by the Eckliff Automatic Boiler Circulator Company, Detroit, Mich.

Ralph T. Coe, manager of the Canadian Sirocco Company, Ltd., of Windsor since the organization of that company, has resigned to enter the engineering service and sales field in New York State. Mr. Coe has been appointed district manager for Warren Webster & Co. and the American Blower Company, and will have offices at 519 Insurance building, Rochester, and 19 Live Stock Exchange building, Buffalo.

OBITUARY

Lawrence Dempsey, owner of the Dempsey Literage & Transportation Company, New York, died at his home in Brooklyn on July 18.

Thomas Clapham, a retired yacht builder and prominent in yachting circles, died on July 19 at his home in Roslyn, Long Island, from heart disease, at the age of seventy-six.

Captain John W. Ferrett, for the past twenty years managing owner of the Bridgeport Towing Company, died at his home in Bridgeport, Conn., on July 18, aged fifty-nine.

Dr. Joseph Austin Holmes, Director of the Bureau of Mines, Department of the Interior, died of tuberculosis at his home in Denver, Col., on July 13, aged fifty-five.

R. C. Scott, secretary-treasurer of the Morris Machine Works, Baldwinsville, N. Y., builders of dredging machinery, died suddenly on July 4 while participating in a golf tournament. Mr. Scott was sixty-six years of age.

John Brown Herreshoff, president of the Herreshoff Manufacturing Company, Bristol, R. I., died on July 20 as the result of a general breakdown. At the time of his death he was seventy-four years old. Mr. Herreshoff became blind when he was fifteen years old, but in spite of this handicap started a shipyard at Bristol for building small boats. In 1873 his brother, Nathaniel Greene Herreshoff, joined him in this enterprise and they began the construction of fast steam vessels. In 1893 the Herreshoffs turned out their first America Cup defender, the *Vigilant,* and since then every other cup defender has been a Herreshoff boat.

Sir Nathaniel Barnaby, K.C.B., formerly director of naval construction of the British Admiralty, died on June 15 at his home in Lewisham. Sir Nathaniel was an honorary vice-president of the Institution of Naval Architects. He was born at Chatham in 1829 and was one of a family of shipwrights who had served in the Royal Dockyard at Chatham for several generations. When only twenty-five years of age he became Admiralty overseer of H. M. S. *Viper* and *Wrangler,* building on the Thames in 1854. From 1870 to 1885 he was head of the designing and building departments in the offices of the controllers of the navy. Finally he held the position of director of naval construction. Sir Nathaniel Barnaby published several volumes dealing with the historical side of the profession of naval architecture. He was one of the founders of the Institution of Naval Architects and a valued contributor to its Transactions.

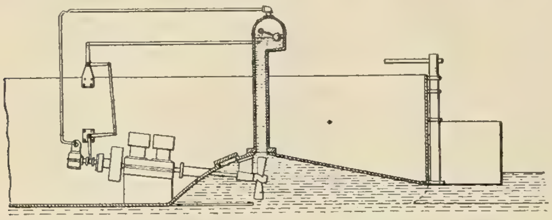
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Derbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,132,923. SHALLOW WATER BOAT. CARL H. FOWLER, OF NEW YORK, N. Y.

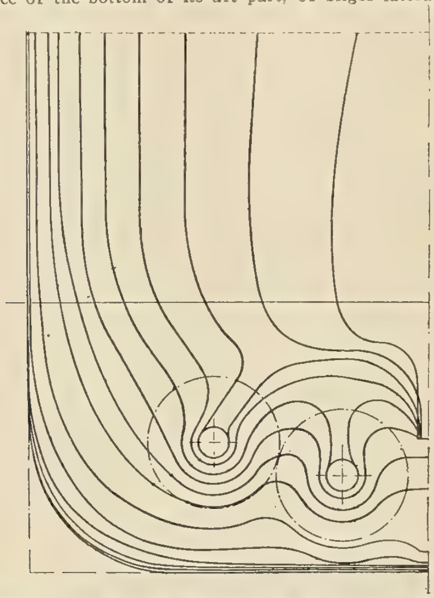
Claim 1.—A boat having a propeller chamber open at the bottom and having a rear wall, the upper part of which slopes at a gradual angle from the horizontal downwardly and rearwardly to the stern of the boat, and extending through the stern with an orifice below the minimum waterline of the boat and above the keel line, a standpipe superimposed



above and connected with said propeller chamber, a vacuum pump, a float in the upper part of said standpipe, and connections between said float and pump such that under certain conditions the pump is set in operation to exhaust the air from said standpipe and propeller chamber and under certain other conditions the pump is rendered inoperative. Ten claims.

1,136,888. SHIP'S HULL. LOTHAR VON KOPPEN, OF STETTIN-ON-THE-ODER, GERMANY.

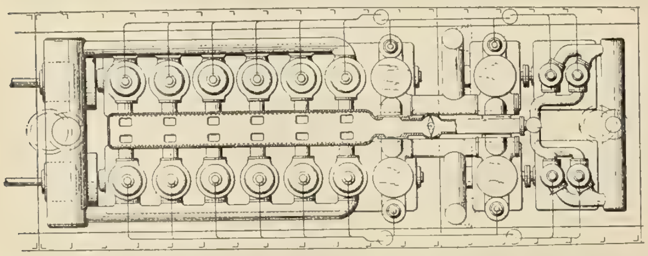
Claim.—In a hull for a ship propelled by three or more propellers, the combination with a plurality of longitudinally extending hollows in the lower face of the bottom of its aft part, of bilges laterally bounding



the said hollows and forming propeller shaft tunnels, the inner shaft tunnel or tunnels ending in front of the outer ones, substantially as set forth.

1,138,077. MARINE ENGINE INSTALLATION. ALFRED BUCHI, OF WINTERTHUR, SWITZERLAND, ASSIGNOR TO BUSCH-SULZER BROS. DIESEL ENGINE COMPANY, OF ST. LOUIS, MO., A CORPORATION OF MISSOURI.

Claim 1.—In a power plant, the combination of Diesel engines arranged in parallelism at opposite sides of a longitudinal center line, there being

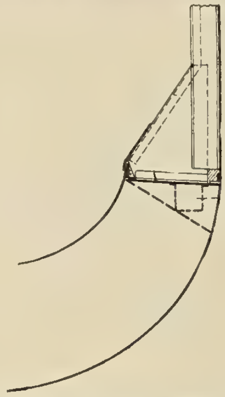


two engines at each side of the center line spaced from each other longitudinally, air pumps located in the spaces between the engines at each side of the center line, and a common scavenging air distribution system supplied by said pumps and arranged between the two proximate sides of the power plant. Six claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

5,517/1914. IMPROVEMENTS IN AND RELATING TO SHIP CONSTRUCTION. R. S. JOHNSON, EIRENE, FORTWILLIAM PARK, BELFAST, AND WORKMAN, CLARK & CO., LTD.

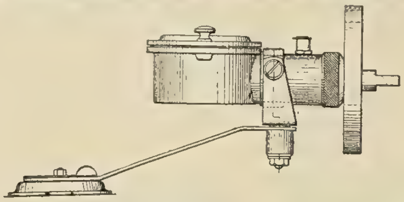
This invention has for its object to provide improvements in the method of constructing the bilges or gutters of ships of the class having their tanks or double bottoms carried out to cover part or all of the turn of the bilge or carried up the sides of the ship for some distance. According to the invention a bilge or gutter is formed above the extremity of the turned-up end of the double bottom or tank at the sides of the ship,



so that, without recessing, the extremity or the upper end of the double bottom or tank forms the floor of the bilge or gutter, the ship's side forming one side of the bilge or gutter whilst the other and inner side thereof is formed by continuous plating secured to the stays or brackets which connect the upper end of the tank or double bottom with the ship's side frames, the continuous plating being extended upwards from the floor of the bilge or gutter to any desired height. By this method of construction a bilge or gutter of any required capacity can be obtained and the plating which forms the inner side of the bilge or pumping gutter also serves to strengthen and stiffen the brackets or staying between the side frames of the ship and the extremity or the turned-up end of the tank in double bottom.

10,883/1914. IMPROVEMENTS IN SHIPS' LOGS. T. WALKER & SON, LTD., AND T. S. WALKER, OF 58, OXFORD STREET, BIRMINGHAM.

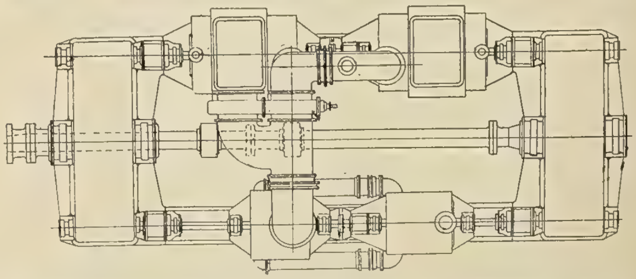
This invention relates to ships' logs and it has for object to render a log more conveniently read than is possible with the constructions at present in use. The log with its dial is capable of being adjusted angu-



larly to the axial line of the trunnions. The portion of the body of the log register is frictionally mounted in a trunnion ring carrying trunnions working in bearings in the gimbal, which gimbal is pivoted in a bearing on the outrigger. Ths outrigger is rotatably mounted on the dished taffrail plate, which is adapted to be fixed to the side of the vessel. The trunnion ring in which the body of the log register is frictionally mounted is provided with an internal spring so as to produce sufficient friction to prevent accidental turning of the register after the position of the dial of the register has been angularly adjusted.

18,105/1914. IMPROVEMENTS IN AND RELATING TO MACHINERY FOR THE PROPULSION OF SHIPS. W. D. McLAREN AND G. M. WELSH, 124, ST. VINCENT STREET, GLASGOW.

The object of this invention is to provide an arrangement of geared turbine propelling machinery whereby the torque is transmitted to the propeller shaft through two independent spur wheels driven by pairs of turbines. Each pair of turbines is arranged on a common axis so that, while the rotors are completely or partially balanced against steam



thrusts without the use of dummy pistons, and in a known manner, one rotor may transmit torque independently of the other. The drawing shows an arrangement of two gear cases containing wheels driven by four pinions from a high-pressure turbine, an intermediate-pressure turbine, and two low-pressure turbines.

International Marine Engineering

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"Unscrewing the Inscrutable"

The bungling efforts of the Administration at Washington to build up the American merchant marine in the foreign trade remind us of the story of the colored preacher who asked close attention of his hearers to the sermon he was about to deliver, as he was going to "divide the indivisible, mention the unmentionable and unscrew the inscrutable." Deadly handicaps have been put on the operating of vessels in the foreign trade by the present Administration apparently for the purpose of preventing private capital going into this branch of shipping. Then because private capital will not make investments of this kind, the Administration brings out again the horrible nightmare of government ownership. The last session of Congress, which had a very large majority vote in favor of the Administration, was decidedly opposed to government ownership, and since Congress adjourned the Chamber of Commerce of the United States has voted on this subject, and by more than eight to one expressed opposition to this form of government. We wish the Administration splendid failure in its attempt to "unscrew the inscrutable."

Steamship and Railway Accidents

In a recent issue of one of the leading railway journals figures were published showing that the risk of a passenger being killed in a train accident is several times less than the risk of his being killed in a vessel disaster. In 1906, for instance, American steamships carried 330,235,959 passengers, of whom 323 were killed in accidents, or 1 in 1,022,000. In the same year the railways carried 797,946,116 passengers, of whom 359 were killed in accidents, or 1 in 2,222,000. Again, in 1914, one passenger in every 3,029,000 carried by the steamships was killed, while on the railways 1 out of every 3,978,000 passengers carried was killed. By restricting the fatalities on the railways to "train accidents" only, the railways are put in a more favorable light, the figures for passengers killed then becoming 1 in 5,465,000 for 1906 and 1 in 12,390,000 for 1914. It must be admitted that in both rail and water transportation accidents are far too numerous. There are no satisfactory grounds, however, upon which the safety of the two modes of transportation can be compared. The causes and nature of the accidents are for the most part wholly different, and in transportation by water the hazards of the sea introduce an element of risk which so far it has been beyond the power of human ingenuity to eliminate. Disasters such as the capsizing of the *Eastland*, or the burning of the *General Slocum*, however, are inexcusable, and the Federal Government should be able to deal with and prevent cases of criminal carelessness and incompetency.

Results of the Eastland Inquiry

The outcome of the numerous inquiries into the *Eastland* disaster in Chicago, which caused the death of 844 persons, has been the indictment, on charges of manslaughter and criminal carelessness, of the officers of the company owning the *Eastland*, the general manager of the company which chartered the boat and the captain and chief engineer of the vessel. The bill against these officials contained five counts stating that the *Eastland* was unseaworthy, her ballast tanks out of repair and not properly filled, the crew insufficient to handle the boat properly, and that 2,500 passengers were allowed on board, which is more than the carrying capacity of the vessel. Commenting upon the causes of the accident, the grand jury stated that the failure to correct the instability of the boat years ago was an indication of criminal carelessness and incompetency on the part of all persons connected with the design, construction, control, operation and inspection of the vessel.

Developing the Port of New York

New York City has 578 miles of waterfront, of which the city owns 127 miles. Only 47 miles of this, however, has been well developed for terminal purposes. In the year 1914, 54.92 percent of all the imports and 36.56 percent of the exports of the United States were handled through this port. To meet future needs, a systematic development of its harbor and terminal facilities must be undertaken, and for this purpose the Committee on Port and Terminal Facilities has submitted a report to the Board of Estimate and Apportionment recommending that a commission be appointed, consisting of John F. Stevens, former chief engineer of the Panama Canal; George F. Swain, professor of civil engineering in the Graduate School of Applied Science of Harvard University, and William C. Loree, formerly general manager of the Baltimore & Ohio Southwestern Railroad, to investigate thoroughly the problem of dock development in the city and to

formulate a comprehensive plan for the proper development of the port. The problem involves a study of the various railway and steamship terminals, their relation to business centers, the method of carrying freight through the streets and the interchange of freight between the railroad and steamship lines. It is estimated that this work will cost about $125,000 (£25,600) per year and that it will take at least two years for completion. There is no doubt but that this work will be the most far-reaching of its kind ever performed for the city of New York. It is work which should have been done years ago; but now that it is finally to be undertaken, the city is to be congratulated upon having it placed in the hands of such competent men.

The Naval Programme

That the naval programme which will be submitted by the General Board this fall will be a very liberal one is generally conceded by all reports emanating from official sources, although as yet its details have not been made public, and probably have not been finally determined. It is believed that this year the Secretary of the Navy and the General Board will agree upon one programme, whereas heretofore two separate programmes have been submitted to Congress, one from the General Board, which calls for a progressive policy of construction based upon what the Board considers as the vital needs of an adequate navy for the defense of the country, and the other from the Secretary of the Navy, which is far less liberal, and is shaped largely by expediency and the probable attitude of Congress towards military preparedness. The events of the past year, however, have brought so forcibly to the general public the importance and vital necessity of adopting a more progressive policy in the upbuilding of the United States navy that the opposition in Congress to naval expansion will undoubtedly be found to have become greatly weakened. Moreover, it is known that the President is favorably disposed towards a more liberal policy in meeting the demands of the naval establishment, and with this attitude prevailing no opportunity should be lost to overcome past delinquencies, and to place the navy on a footing commensurate with the rapidly increasing responsibilities of the nation's foreign relations.

In many ways the present period is a critical one as far as the relative value of different types of war vessels is concerned. Questions which in times of peace have been subjects of controversy, such as the importance of submarines in naval warfare, defense against torpedo attacks, the relative value of high speed in capital ships, and similar problems, are now being worked out in actual warfare. Such information as has been gained by naval observers abroad, of course, will have an important bearing on the nature of the naval programme, and for this reason the report of the General Board has been deferred until fall.

In accordance with the policy which the General Board has steadfastly adhered to, it will probably recommend at least four first-class battleships. This was the number asked for last year, when the Board reported that the fleet was deficient by ten battleships of the programme laid down in 1903. As only two battleships were authorized by Congress at its last session the deficiency of the fleet in vessels of this type has been increased. It is very probable, however, that the recommendations of the General Board will for the first time include battle-cruisers, as the great value of this type of vessel has been demonstrated in the present war. Scout cruisers—a type of vessel which has been entirely neglected in the navy since the building of the *Birmingham, Salem* and *Chester*—will be recommended, although probably only four will be asked for.

In view of the spectacular achievements of the submarines in the present war, and the continued activities of the belligerent nations in adding to their fleets of submarines, it is probable that a large number of these vessels will be asked for. They will be of two types—the coast defense submarine and the large cruising submarine. Various estimates have placed the number at from twenty to fifty. At least sixteen torpedo boat destroyers will be recommended, although more would be required if the ratio of four destroyers to each battleship in the fleet is to be attained, as the present ratio is less than half of that number. If the programme for destroyers and submarines is realized, tenders for both of these classes of ships will be required. The navy is also extremely deficient in small gunboats for patrol duty.

For naval aviation a large sum will be recommended in order to provide for the construction of aircraft and for the expansion of the aviation schol at Pensacola, Fla. Extensive additions to existing naval gun shops, torpedo plants and powder factories will also be recommended, together with additions to the auxiliary fleet of colliers, transports, hospital ships and supply ships. The weakness of the navy in auxiliary vessels is too well known to need further comment. This essential branch of the navy is something that cannot be supplied over night in case of emergency, and immediate steps should be taken to overcome this deficiency.

No information has been disclosed, of course, as to the characteristics of the vessels included in the new programme. Plans and specifications of the two new battleships authorized by the last Congress are now being completed, and these ships will be very similar to the preceding vessels of this class. Although turbine propulsion is adopted in the Department plans an opportunity will be given to bidders to submit alternative designs for the machinery, and in this way it is certain that the adoption of electric drive will receive careful consideration. The only new features in the new ships will probably be in the manner of subdivision and armoring of the hull to resist torpedo attacks. Recent experiments carried out by the Bureau of Construction and Repair on armored caissions to determine the effectiveness of subdivision and armor for this purpose, it is understood, have furnished sufficient evidence to enable the Depart-

ment to make important improvements in this feature of design. Both the destroyers and submarines authorized in the last programme represent steps in advance in their respective classes—the large cruising submarine, which will be named the *Schley*, being a distinct departure, and probably the forerunner of a new ship's type.

Performance of Diesel-Engined Motor Ships

In view of the skeptical views expressed by many shipowners regarding the success of Diesel-engined motor ships, we call attention to the following extracts from a report, dated June 1, 1915, made by the Anglo-Saxon Petroleum Company, of London, owners of nine Werkspoor Diesel-engined ships, ranging from 500 to 2,200 horsepower. The report refers especially to the *Selene*, of 2,200 horsepower and 5,413 tons deadweight carrying capacity. The liquid fuel capacity of this vessel is 692 tons. With full bunkers the vessel can travel 22,800 miles without repleshing her fuel supply.

"After satisfactory trials, at which a speed of 11.3 knots was obtained, being ¾ knot above contract, the *Selene* was accepted from the builders in September, 1914, since when she has been regularly in employment, and has now traveled a distance of over 40,000 miles.

"On the voyage just completed she left Cardiff on December 19, 1914 (after her first guarantee overhaul, lasting twelve days) for Port Arthur, Texas. She then proceeded, via the Panama Canal, to North China; distance Panama-North China, 9,000 miles. (This was covered in 44 days without calling at any port.) After discharging her cargo, for which purpose she was in port four days, she made for Singapore, where she replenished her stock of fuel, having covered 14,300 miles without taking fuel at any intermediate port.

"This would not be an economical procedure in the ordinary course with a steamer, as it would result in shutting out a considerable amount of cargo, but in the case of the *Selene*, although the captain had instructions to replenish bunkers at Shanghai, he found the consumption on the run across the Pacific so economical that no additional fuel was needed at Shanghai, and with a full cargo of oil the vessel was able to steam 54 days, and in ballast 12 days, at practically full power without replenishing her fuel supply. On her last voyage the *Selene* effected a complete trip round the world, covering a distance of approximately 27,500 miles.

"It might have been reasonably expected that in the course of their first six months' running defects in the machinery would become manifest, as is mostly the case in new departures of such a radical nature, but somewhat regardless of the apparent risk, these vessels were sent across the North Atlantic and Pacific in the depth of winter as soon as they left the builders hands, and instructed to perform long-distance runs which even in the case of a new steamship would not have been quite desirable; in fact, no discrimination whatever was shown in adjusting the movements of these vessels, which have been treated as if they were ordinary steamers, and perhaps a little more severely.

"Another example of this is that the sister ship *Artemis*, after having been kept running continuously for eight months without dry-docking since the date she was accepted from the builders, has now been sent on a voyage from the Tyne, where she left on March 6, to Port Arthur, and from there through the Panama Canal to Sydney, Australia, the distance from Panama being 8,000 miles. The *Artemis* left Panama on April 17 and arrived at Sydney May 24.

"It is particularly to be noted that no facilities for repairs to Diesel machinery are available in those parts of the world, and it may be regarded as a demonstration of the great faith we have in the absolute reliability of the machinery of these vessels. It is also obvious that on these long-distance runs—where bunkering stations for steamers are few and far between—the motor vessel presents an enormous advantage by the comparatively small amount of bunkers required and the large cargoes they carry in comparison with steamers.

"The foregoing facts will show that our Diesel vessels, the machinery of which have all been constructed at the Werkspoor firm of Amsterdam, have been subjected in the first period of their running to the most severe tests, and having proved capable of standing tests better than could reasonably have been expected, we feel entirely assured of the great success we have attained with these vessels. They have now gone through their first and most trying period, and with small adjustments and improvements introduced the machinery will become more reliable as time goes on. We feel that in spite of disappointments with some Diesel-propelled vessels, there is a great future for the marine Diesel engines.

"In presenting the above particulars regarding our new vessels, we cannot refrain from again bringing to your notice the work which our little tanker *Vulcanus* has performed. We particularly desire to emphasize the fact that this boat, built in 1910 and accepted from the builders in November of that year, was the first sea-going Diesel tanker in Western Europe, and it was from this pioneer ship that we gained our present knowledge and experience in the matter of the requirements of sea-going Diesel ships, and through this boat was largely achieved the present stage of reliability and development.

"It is significant that the *Vulcanus* still shows herself to be a thoroughly useful and dependable motor ship, and we look upon her as an all-round success. A remarkable feature is that, apart from being regularly employed in our coasting trade, she has on more than one occasion been kept running for ten consecutive months without dry-docking. The latest example of this is that she was dry-docked in January, 1914, the delay for overhauling purposes being only ten days; she then ran continually till November 17. During this period the total time lost for engine repairs was 16 hours in port and 17½ hours at sea, a performance sufficiently striking to place the good qualities of this small boat beyond dispute."

Fig. 1.—S. S. *Transmitter*, Specially Designed for Repairing Submarine Cables

Cable-Repairing Steamer Transmitter

Single Screw Vessel Built by the Goole Shipbuilding Company for the Eastern Telegraph Company, Ltd., of London

BY F. C. COLEMAN

At the present time there are in service about sixty ships specially designed and equipped for the laying and repairing of submarine cables. One of the most interesting of this special type of ship is the single screw steamer *Transmitter*, which forms the latest addition to the fleet of ten cable-repairing steamers belonging to the Eastern Telegraph Company, Ltd., of Finsbury Pavement, London, E. C.

The *Transmitter*, built by the Goole Shipbuilding & Repairing Company, Ltd., has a main deck, topgallant forecastle, awning bridge and a short poop. The following are her leading dimensions:

Length overall	221 feet 4 inches
Length on load line	200 feet
Breadth, extreme	30 feet 1¾ inches
Breadth, molded	30 feet
Depth, molded	17 feet 6 inches
Gross tonnage	903

The vessel is constructed of Siemens-Martin mild steel, and is steel riveted, and although classed in Lloyd's Registry 100 A1 with special survey, certain scantlings and parts in the construction are above Lloyd's requirements. There is a flat keel plate with butts planed and flush, and the butt straps are 3/20 inch thicker than the keel plates.

Fig. 2.—After Deck

Fig. 3.—Forward Deck

The stem is forged and swelled at the foot to take the keel plates. The stem bar is 7¼ inches wide (Lloyds 6½ inches by 2 inches). This extra width allows for the chafe of the cables, but the shell plates are kept back, as if the stem bar were only 6½ inches wide. The head of the stem is finished in accordance with the plan, so as to allow for the box-end to carry the bow gear. The stern frame has substantially forged gudgeons, steel bushed, to take the rudder pintles, and there are ample forged locking stops. The rudder has a single steel plate with forged iron head and faced coupling on the lower end. The braces and gudgeons are forged, the upper

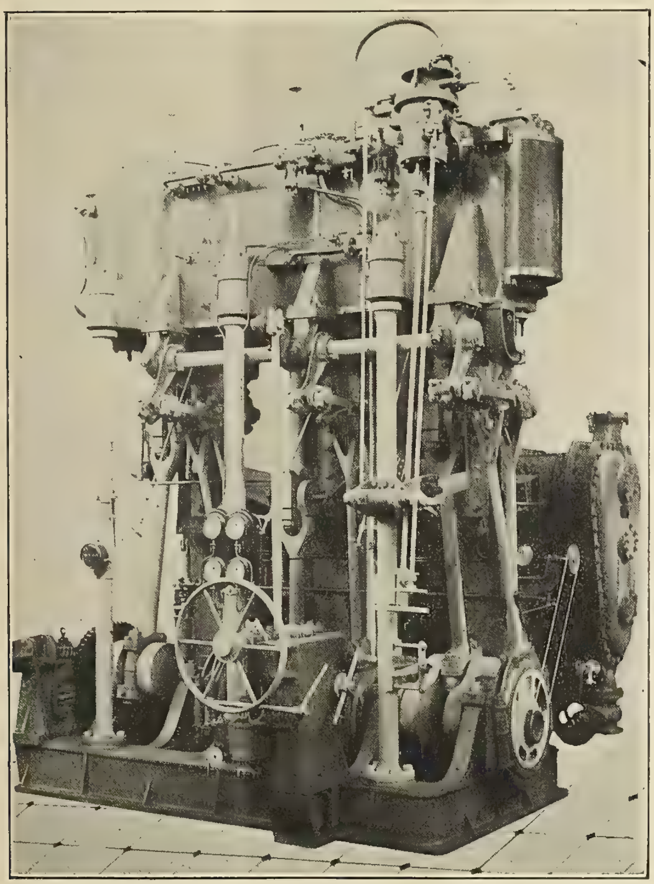


Fig. 4.—Main Engine

gudgeon locking with that of the stern post. There are portable turned pintles with coned ends, nut and split pin, and a stuffing box at the rudder head.

The frames are spaced 22½ inches apart and are of bulb angles, 6½ inches by 3 inches by .40 inch. All of the frames are run up to the gunwale plate top of the forecastle deck, to the main gunwale aft of forecastle to the front of the awning bridge and to the top of the sides of the awning bridge deck, thence to the main gunwale right aft. Counter transoms and poop frames are arranged and frames are cut at the margin plates of the forward ballast tanks, while small limber holes are in all of the frames and floors at the level of the top of the cement.

The reverse frames are chiefly angles 4 inches by 3 inches by .34 inch, and where there are no reverse bars lugs of larger angles for stringers are riveted to the frames.

The web frames are arranged two on a side in the forecastle to suit the ends of the tanks and at the flare of bow

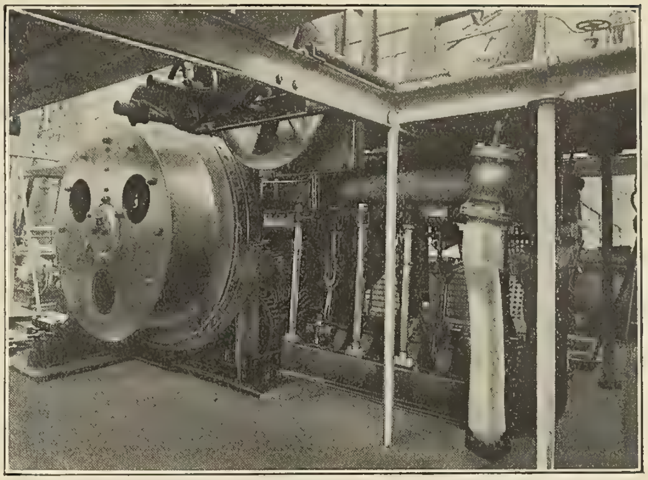


Fig. 5.—View of Cable Gear, Looking Forward

of 9-inch bulbs. In the cable gear there are two web frames on each side 12 inches wide, with a 12-inch channel steel beam at the top of each web frame, and a 9-inch web frame takes the channel steel beam at the back of the boiler.

The whole length of the vessel has ordinary floor plates carried straight across. The floor plates are sheared ½ inch clear above the bottom of the frames. The deep floors aft through which the stern tube passes are .34-inch thick, with suitable access and manhole door from the watertight flat.

Forward Tanks

The three forward separate tanks, Nos. 1, 2 and 3, are divided on the centerline with watertight division and piping and suction serve both sides of the tank, the piping being carried through the bulkhead bunker into the stokehold and there connecting on to piping to the pump. Easy access is obtained to all the ballast tanks by means of McNeale's patent manhole doors. There are strong galvanized iron box strums with hinged lids to all suctions, and all the bends of piping are protected where passing corners of steelwork with properly fitted chocks.

The ballast tanks (Nos. 3 and 4) next the after engine room and forward bunker bulkhead are reserved for fresh water for the main boiler and have separate piping and cocks to main feed pump in the engine room. The tops of the ballast tanks are covered with Wailes, Dove's bitumastic cement, and there is a light calked ceiling 2

Fig. 6.—View of Cable Gear, Looking Aft

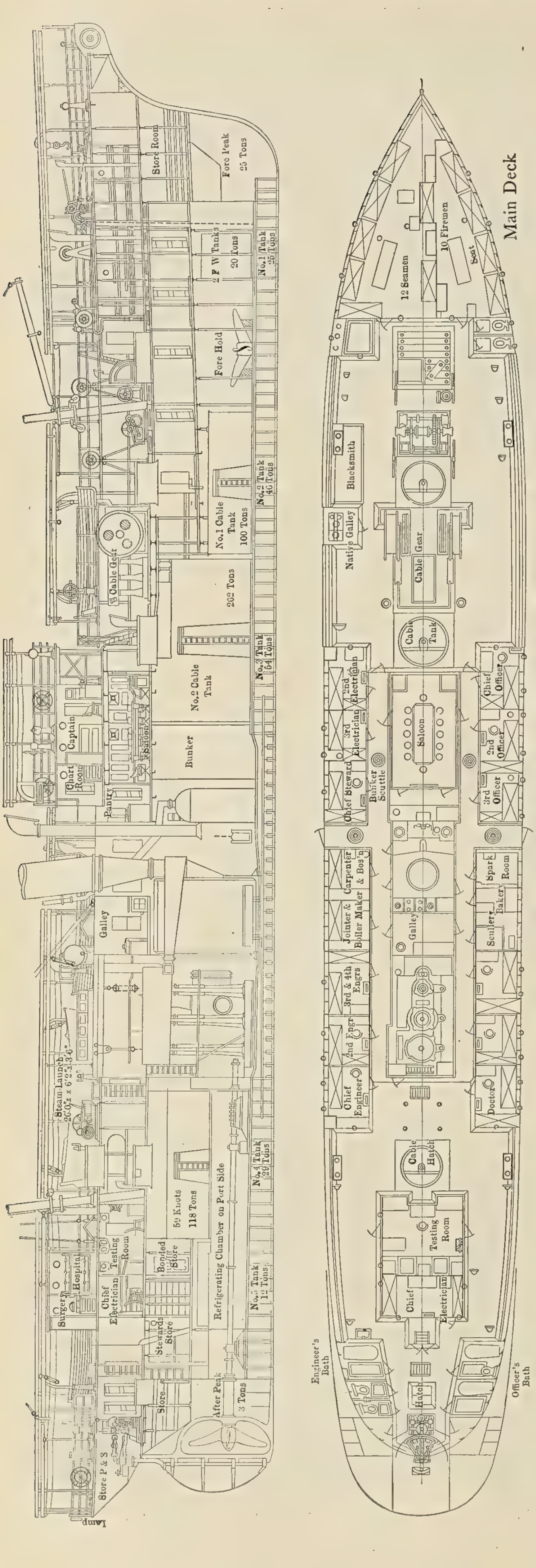


Fig. 7.—Inboard Profile and Main Deck Plan of the *Transmitter*

inches thick where necessary. The lower parts of the bulkheads from the keel to about 4 feet above the tank tops are .32, upper parts .28, except the bulkheads to fore and aft peaks, which are .32 throughout.

The main bulkhead, partly formed by the after end of No. 2 cable tank with wide partitions was specially considered with regard to scantling and detail and the after end of the cable tank was covered with a 2-inch thickness of African asbestos, with groundings of 2-inch ceiling, joiners' screws, and occasional tap screws being used. Where side stringers pass through the bulkheads they have steel shoes fitted on the bulkheads and to stringers and are calked. The overlapping butt-ends of the plates are planed and all the landings are joggled. At all the spigoted engine valves, or sea-inlets, the discharges and under sounding pipes have doubling plates fitted closely in one space of frames. The sides of the houses are plated with outside butt strips, as also all deck structures with deep and strong coamings.

The bilge keels for half-length amidships are of 10-inch by 8/20-inch bulbs, and a tee bar 5 inches by 3½ inches by 8/20 inch. The bulb bars are tapered at each end, and the fore ends have shaped Jarrah wood chocks with galvanized iron bolts through and through.

From forward of the cable gear to the first beam aft of the after main bulkhead and between the gunwale stringer plates are .30-inch thick plates across the vessel, butt strips and amidship tie plates. The angle, 3½ inches by 2½ inches by ⅜ inch, is worked along each side to take the teak margin plank and to form a waterway. The main keelson is lowered under the boiler so as to be intercostal within the main boiler space, and the angles on the top of the floors and those taking the intercostal plating are of such scantling as to give the maximum clearance under the boiler.

Cable Tanks

In the forehold there is a tank 21 feet diameter by 6 feet 6 inches deep, and another tank 24 feet diameter by 12 feet deep, while in the after hold there is a third tank 22 feet by 6 feet 6 inches deep. The tank cones are 5 feet diameter at the base and 4 feet diameter at the top, with 5/16-inch plate, with butts planed and butt strips fitted internally. There is a special arrangement of heavy stanchions, 3½ inches and 3 inches diameter, fitted under the cable gear, also on the top of the fore end of No. 2 cable tank, while there are stanchions under the masts, the forward ones under the hold being placed so as to give the maximum clear space for the cable buoys.

The disposition of the various apartments and machinery spaces is so clearly illustrated in the drawings as to render unnecessary any further detailed reference. The *Transmitter* is designed to carry a crew of fifty-five. The captain's quarters are on the bridge deck, and comfortable, well-fitted accommodation for the officers, electricians and engineers is provided on the main deck. On the lower deck aft of the engine room is the engineers' workshop, with entrance from the engine room, and there is here a small vertical engine driving shafting and pulleys and fitted to the under side of the main deck and working a lathe and a drilling machine. There is also a workman's bench supplied with vise complete.

On the forecastle, bridge and main decks there are the most modern appliances provided for the delicate and difficult services of laying and repairing submarine telegraph cables. This equipment comprises a steam cable machine, two dynamometers, turning-over gear and bow sheaves and a Lucas sounding machine.

The cable gear, constructed and installed by Messrs.

Johnson & Phillips, Ltd., of the Victoria Works, Charlton, S. E., is claimed to be the most highly finished machinery of its class fitted on any cable steamer. Every gear wheel, even the large gears on the main drums which have 70 teeth 3¼-inch pitch, was machine cut from the solid, all the larger wheels being of cast steel, while the pinions are of Immadium bronze. Several of the steel wheels were "muffled" in accordance with a suggestion of Messrs. Johnson & Phillips, so as to eliminate the "ring," the result being that the gear works with a minimum of noise and rattle.

Cable Gear

The cable gear is a combined picking-up and paying-out machine having two drums, but with one engine, the drums being independent of one another, so that while one is picking up, the other can be paying out under control of the brake. The drums run loose on the drum shaft, which is a fixture in the frames, making a very rigid job. They are internally geared and are connected to the second motion shaft by machine-cut bronze pinions which are carried on a shaft in special pocket bearings attached to the main frame, and so constructed that the pinion can slide into gear through large holes in the frames, making a very compact job. The engine is coupled to the first motion shaft by means of machine-cut bevel gear. The drum pinions and the speed wheels are slid into gear by means of wipers actuated by worm gearing and handwheels from the platform deck above.

All the controlling mechanism is arranged on the top deck, the steam stop valve, reversing lever, main brakes, holding back gear brakes, all being within arms' reach of the attendant. The drums are 5 feet 8½ inches diameter on the tread by 1 foot 7 inches wide between the flanges, and they are geared for two speeds, for nominal lifts of 15 tons at one knot, and 6 tons at 3 knots, but the engine is a very powerful one, having three cylinders 11½ inches diameter by 13 inches stroke, thus enabling the gear to deal with any lift that it may be called upon to do.

Evidence of this was given while the lift tests were being made, the load of 15 tons being picked up with great ease, and the valve gear is so adjusted that it is possible to haul up quite steadily even a few inches. Each drum is provided with a large brake ring, encircled by a brake band consisting of steel straps fitted with elm blocks, and on the back of each strap a water service pipe is attached having small nozzles at intervals to allow the water to be delivered equally all around the brake ring, so as to permit of paying out fairly long lengths of cable.

The propelling machinery was constructed by Messrs. Richardsons, Westgarth & Co., Ltd., of Hartlepool, according to a specification embodying the latest improvements for a vessel of this class, special attention having been paid in the case both of the main engines and auxiliaries to secure economy of steam consumption and fulfil the exacting requirements of a cable ship. The bearing surfaces throughout are exceptionally large and great care has been exercised in the design generally to secure accessibility of all the various working parts and of the larger number of auxiliaries contained in the engine room.

Propelling Machinery

The engines are 17 inches, 28 inches and 46 inches diameter by 33 inches stroke, each being steam jacketed and fitted with flat, balanced slide valves, the low-pressure having its valve placed at the back of the engines in order to economize space. The reversing gear is of the all-round type, driven by a powerful and specially designed engine to facilitate the rapid handling of the main engines when the vessel is engaged in cable work.

The condensing and feed heating arrangement is very complete. This comprises the latest development of "Contraflo" system with compensator exhaust steam surface feed heater, with which is combined an oil separator and oil extractor. The main condenser is of the "Contraflo" type, designed to maintain a high vacuum in all temperatures of sea water, which is specially applicable to a ship engaged in tropical waters; the auxiliary condenser is also of the "Contraflo" type. The main feed pumps are of the slow speed independent type and work in connection with a Cascade filter arranged with float

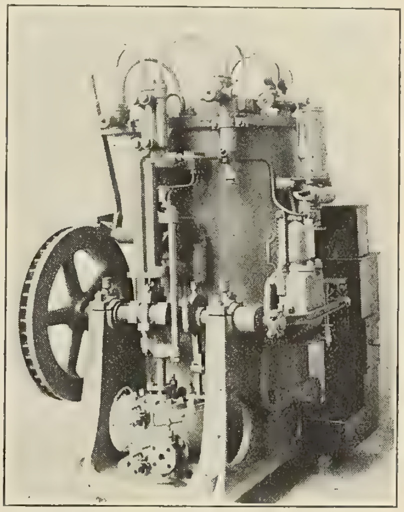


Fig. 8.—Steam-Driven Combined CO_2 Type Refrigerating Machine of the *Transmitter*

control. The accessories on the main engines include an Aspinall's governor, speed indicator, and revolution counter for cable work, etc., and in addition to the auxiliaries forming the "Contraflo" system a separate centrifugal pump is fitted, also auxiliary feed pumps, large ballast pump, Morison's evaporator, etc.

In the engine room are also installed the electric light and refrigerating plants. Steam is supplied by one large forced draft boiler fitted with "Economic" fronts and Sturrock's bridges. The working pressure is 175 pounds per square inch. The fan and engine are by Bumstead & Chandler and the stokehold fittings include a Compton's ash hoist, etc.

On the trial trip, which took place off the mouth of the Humber, a mean speed of 11.2 knots was obtained and the engines and all auxiliaries worked in a most satisfactory manner.

Refrigerating Machinery

The refrigerating machine was supplied by Messrs. J. & E. Hall, Ltd., of Dartford, and is one of their steam-driven CO_2 type, and, as will be gathered from the illustrations, the machine forms a very compact and complete unit. The CO_2 compressor is driven direct by the steam cylinder, which can be seen carried in the bottom of the frame. The brine pump and the condenser water circulating pump are both driven in tandem off the end of the crankshaft. The body of the machine forms a casing for the CO_2 condenser coils, around which the condenser water is circulated by means of the pump already mentioned. Inside the base of the machine a wrought iron casing is fixed, the space between the inner casing and the outer

casing being filled with granulated cork for the purpose of insulation. The evaporator coil is placed inside the wrought iron casing. Around this coil the brine is circulated through electrically-welded grids, which are fitted in the provision rooms, and by this means a low temperature is maintained for the preservation of the food for the use of the officers and crew. A special tank for the production of ice is also supplied.

There are two large refrigerating chambers, for the preservation of meat and vegetables, in the after hold, with a complete system of brine piping carried from the ice machine. Fresh provisions and a supply of ice naturally add very greatly to the comfort of the officers and crew, particularly when the vessel is working in hot climates.

Electric Plant

The electric light installation is a very comprehensive one, and was carried out by Messrs. Clarke, Chapman & Co., Ltd., of Gateshead-on-Tyne. The engine is of the open marine type, single cylinder, double-acting, coupled to a compound wound dynamo with an output of 100 amperes, 100/105 volts, when running at a speed of about 350 revolutions per minute. The contract also included the supply and erection of the main switchboard, cables, wiring, section and distribution boxes, fittings, fans, lamps and the usual accessories for no fewer than 235 points and 226 lights and 15 fans, as also the masthead light, three cable lanterns, and one Morse Signaling Lantern on the masthead, which latter is of Wightman's patent.

The deck machinery includes a powerful windlass, manufactured by Messrs. Emerson, Walker & Thompson, of Gateshead, which is fitted on the forecastle deck. There is a combined steam and hand steering gear manufactured by Messrs. R. Roger & Co., Ltd., which is fitted within the poop, and is controlled by a system of rods and a wheel from the navigating bridge.

Inclusive of a steam launch there are eight boats. The steam launch, supplied by Messrs. H. Hamblin & Co., of Blackwall, E., has a length overall of 26 feet, a depth molded of 3 feet 6 inches, and a beam of 6 feet 2 inches. It is built of mahogany, and the stern chock is of stout oak, well bolted. The compound steam engine, of Mumford's type, is capable of giving the boat a speed of about 9 knots. This launch is designed for towing cables, etc., and other hard work at sea.

Wireless Installation

The wireless telegraph installation, manufactured and erected by Messrs. Siemens Bros. & Co., Ltd., Woolwich, upon the quenched spark system for which it is claimed an efficiency of from 50 to 75 percent is obtained, the efficiency of the old open spark stations being only from 25 to 33 percent. The adoption of this system has also made the building of a special cabin and spark gap chamber unnecessary upon the *Transmitter*, the quenched spark installation being practically noiseless. Another advantage obtained by the adoption of the quenched spark system is that, the note emitted being musical in character, the station can be heard even when electrical discharges are as much as ten times as intense. A much longer period of working is thus obtained, together with an increased range.

The source of energy of the installation is a motor generator set consisting of a direct-current motor of about 1½ horsepower driving an alternating current generator of 1 kilowatt output at 220 volts, 500 frequency. The speed of this motor can be adjusted over a range of about 30 percent of the normal speed for the purpose of adjusting the pitch of the note transmitted. This motor generator set is installed in what is known as the "spark room," and the necessary leads run from there to the wireless telegraph apparatus proper, which is situated in the cable-testing room.

The alternating current from the generator is stepped up from 220 volts to 8,000 volts by means of an iron core transformer. A choking coil is provided in the low tension circuit in order to obtain the necessary resonance between the low tension and excitation circuit. The excitation circuit consists of an iron-cased condenser with glass dielectric and oil insulation, an inductance of copper strip and a quenched spark gap. The latter consists of a number of copper plates silver-faced, separated by mica rings.

The excitation circuit is enclosed in a wooden case upon the back of which is provided a hot-wire-ammeter. Slots are cut in the top of this case, through which plug sockets are fixed corresponding to the positions required for the inductance for the 300 and 600 meter wave-lengths. Connections are made from these plug sockets to an inductance of the variometer type, which serves to obtain the correct resonance between the excitation circuit and aerial.

Range of Wireless Station

The receiver is of the well-known Siemens Telefunken type, which combines long wave-length range together with simplicity of operation. The detectors, two of which are mounted upon the receiver, are of the contact type. The coupling of the primary and secondary coils of this receiver is capable of very large variation. The wavelength of the receiver is from 200 to 2,000 meters. In order to prevent damage to the detectors and receiving apparatus during transmission, a special form of switch is provided at the back of the receiver which insures that transmission cannot take place until all the receiving circuits are broken by means of this switch. The ranges over which this station will work have been guaranteed as 150 nautical miles by day and about 250 miles by night, but from the previous experience of Messrs. Siemens it is expected that the actual working range will be greatly in excess of these figures.

As the *Transmitter* will be required to work in tropical climates, special consideration was paid to the lighting and ventilation of the various apartments and machinery spaces. Two sidelights and separate ventilator cowls are fitted to each cabin, while the workshop, lower deck and crew space are all well lighted and fitted with large ventilator cowls, and all of the ventilators are carried well over the weather deck. Double canvas awnings are fitted from stem head to stern.

Sanitary provision is made according to the conditions of the vessel's working stations abroad, for besides the making of ice, there is a hospital fitted with two Admiralty cots, a porcelain bath, a sofa and a small, fitted-up surgery.

In the design of the vessel regard has been given to her working in shallow waters and good stability with easy motion when at sea. It will also be seen that within limited dimensions endeavor has been made to bring this cable-repairing vessel up to date. The hull and machinery of the *Transmitter* were built to the specification and under the supervision of Mr. P. L. Isaac, the superintending engineer of the Eastern Telegraph Company, Ltd.

Monthly Shipbuilding Report.—The Bureau of Navigation, Department of Commerce, reports 139 sailing, steam and unrigged vessels of 16,565 gross tons built in the United States and officially numbered during the month of July. In accordance with the act of August 18, 1914, two foreign-built vessels of 2,910 gross tons were added to the American merchant fleet during the month.

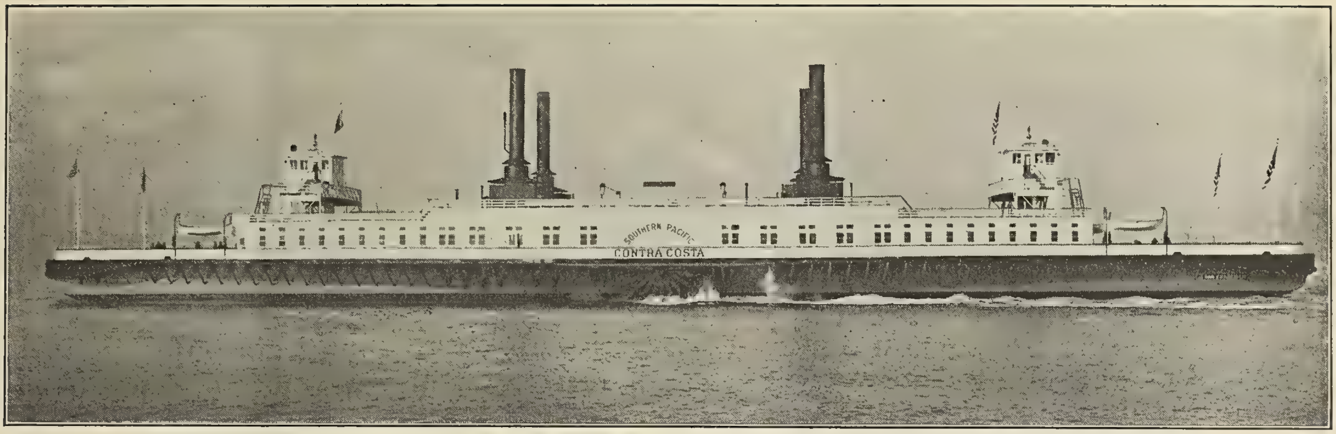


Fig. 1.—The *Contra Costa* on Her Trial Trip

Side-Wheel Car Ferry Contra Costa

Details of Design and Construction of Largest Side-Wheel Train Ferry in the World

BY EDWARD W. OLIN

The Southern Pacific Railroad Company recently placed in service the new side-wheel car ferry steamer *Contra Costa,* which is probably the largest car ferry of her type in the world. She was especially designed to carry freight and passenger trains across the Carquinez Straits between Port Costa and Benicia, Cal., which lie on the company's trans-continental lines.

The steamer is of the following dimensions:

Length overall	433 feet 4 inches
Length over transoms	420 feet
Width over guards	116 feet
Beam, molded	66 feet 6 inches
Depth, molded	19 feet 5 inches
Light draft	5 feet 10 inches
Light displacement	3,400 tons

While a brief description of the *Contra Costa* appeared in the November issue of INTERNATIONAL MARINE ENGINEERING, it is the intention of this article to give a more detailed account of her design and construction, as several inquiries concerning her have already been made, testifying to a more than local interest in this boat.

The boat is constructed entirely of Oregon pine at an approximate cost of $400,000 (£82,500) and is to relieve the old steamer *Solano,* which has been in almost continuous service since 1879. Until the completion of the *Contra Costa* the *Solano* was regarded as the largest car ferry in the world, being exceeded in length by the new ferry by only 13 feet.

The service for which she is intended is unusually severe, making an average of 46 trips with trains every 24 hours. No especial rules are observed in loading or unloading trains other than to load the first train on the

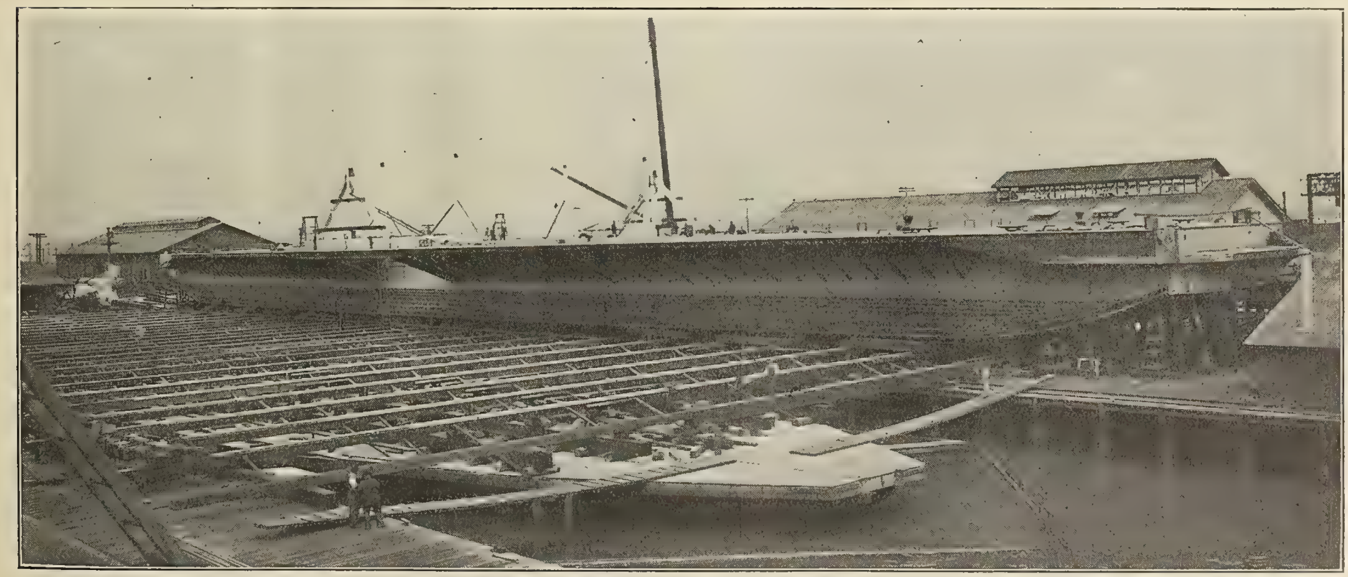


Fig. 2.—The *Contra Costa* Ready for Launching

Note that the boat is side hauled about 100 feet into a Crandall marine railway from which she was launched. Nineteen minutes were required to side haul the boat.

inside tracks. It is usual, in the case of long trains, for the locomotive to pull her train aboard after breaking the train in the several units, while a switch engine fills up the other tracks and goes across with the cargo. It is no uncommon sight to see the heavy locomotives stand

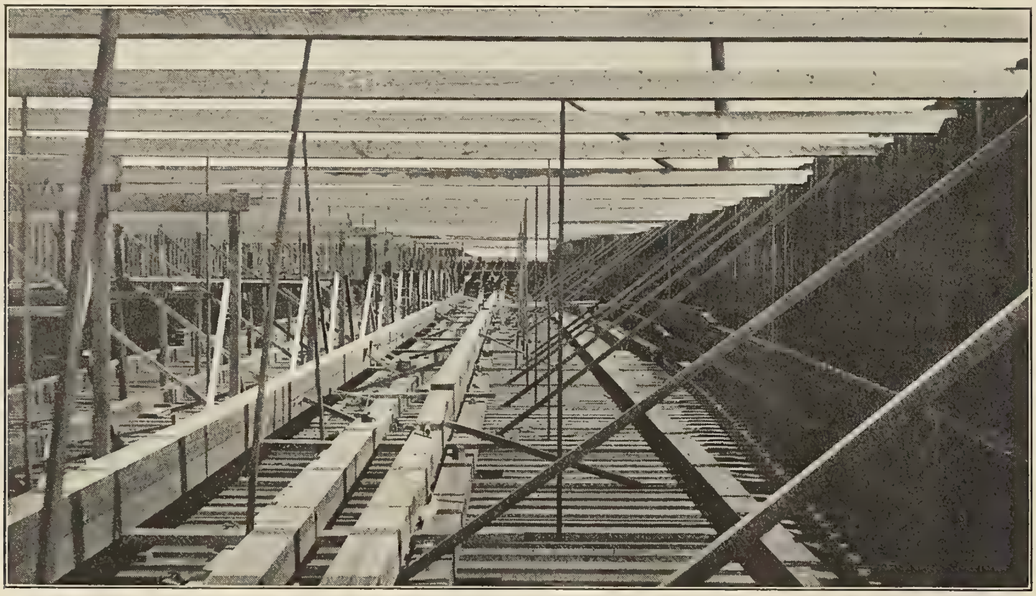


Fig. 3.—Inside View from One End of Hull, Looking Fore and Aft

on diagonally opposite corners, thereby subjecting the hull to very severe twisting strains. As the boat is operated in connection with the regular train schedules it is obvious that absolute reliability is a most essential factor, and any delay in the operation of the boat means a readjustment of the time-tables with its attending confusion. No expense was therefore spared in the equipment of engines, boilers and auxiliaries, all of which are designed with plenty of reserve power.

The Carquinez Straits is a narrow strip of water, one mile wide, connecting the San Pablo and Suisun Bays. There is a rise and fall of tide of 10 feet, while the ebb and flow of the tide create a current of 7 miles per hour. The trip across is made in 8 minutes, which includes making the boat fast in the slips and to the aprons.

Four tracks, 12-foot centers, extend the full length of the deck, giving a total of 1,680 feet of track, which is

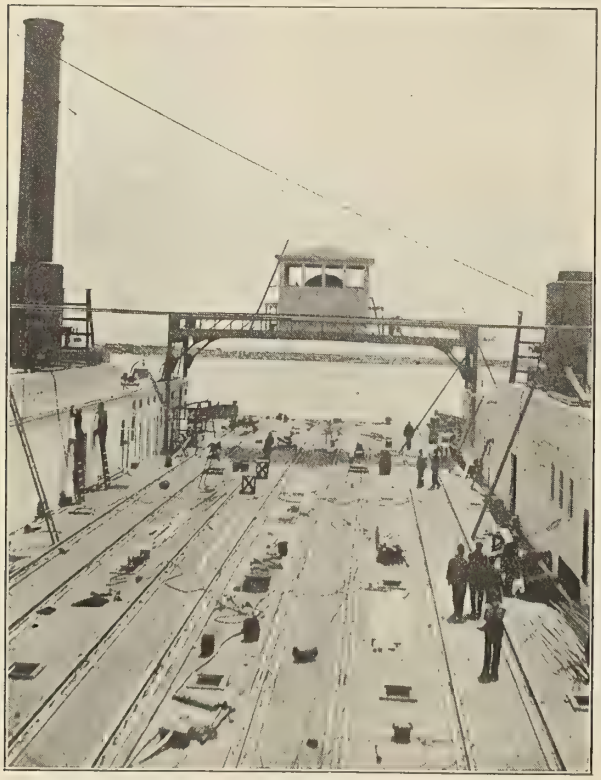


Fig. 4.—View of Main Deck, Showing Railway Tracks Spaced 12 Feet Between Centers

Fig. 5.—Driving a $1\frac{1}{8}$-Inch Diameter Drift Bolt 7 Feet Long Through 26-Inch Waterway

entirely unobstructed by hog posts, hog chains or masts, giving a very clear and open deck. A pilot house is

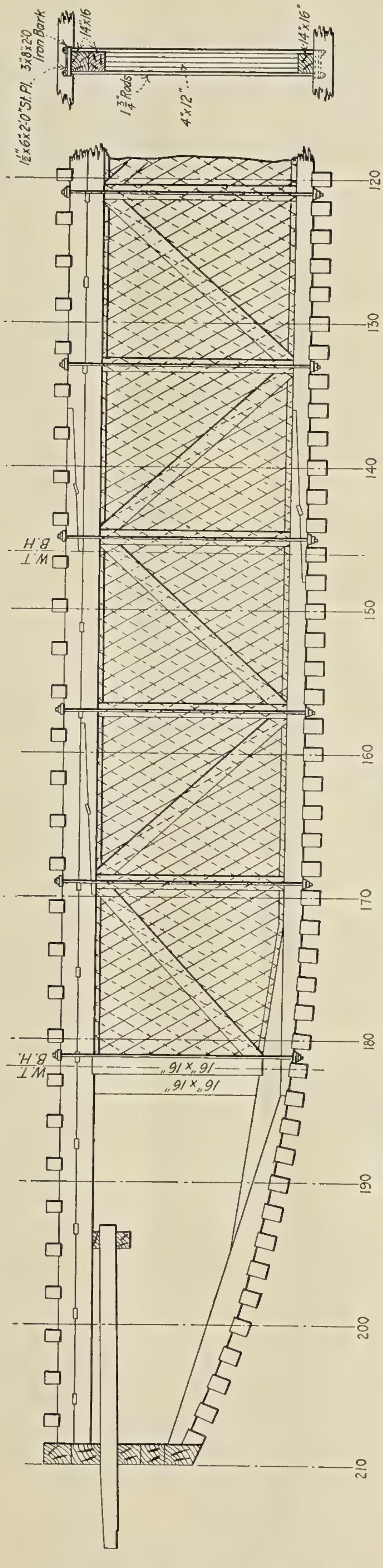


Fig. 6.—Construction of Longitudinal Bulkheads, Located 6 Feet and 18 Feet, Respectively, from Centerline of Ship

located on a steel bridge on each end of the boat. The superstructure extends 275 feet fore and aft on each side of the boat and encloses all the boilers, engineers' stands and operating platform; a restaurant and galley; a bar; a ladies' lavatory and waiting room; a men's lavatory and waiting room; a carpenter shop and ship stores, and the usual accommodations for the officers and crew, besides a waiting room and office for the accommodations of the train crew.

When fully loaded the *Contra Costa* will accommodate 36 freight cars and 2 locomotives, or 17 standard Pullman passenger coaches and 3 locomotives.

Hull Construction

As may be expected, the lines are similar to those of an ordinary barge; the sides are vertical, fairing in from 66 feet 6 inches beam amidships to 46 feet at the transoms,

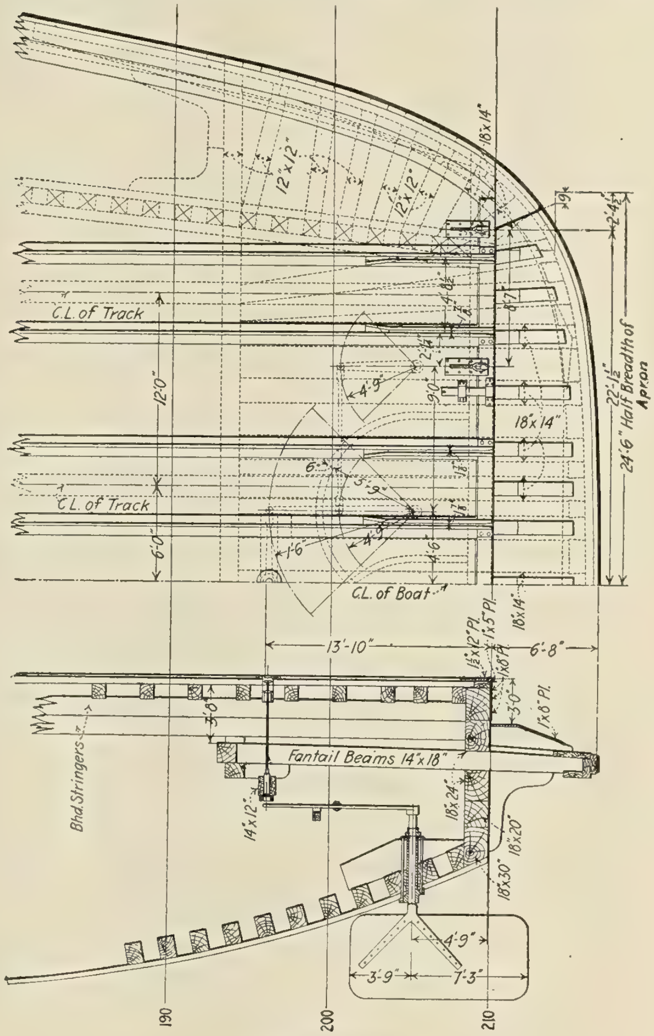


Fig. 7.—Fantail

with an 8½-foot rise of keel on each end, commencing about 35 feet from the transoms.

More than 2,000,000 feet of lumber were used in the construction of the hull alone and about 105 tons of galvanized iron fastenings. Some of the largest timbers in the boat were the six wheel beams, each of which is 18 inches by 18 inches by 116 feet long; two spring beams, each 26 inches by 36 inches by 66 feet long, and the timbers of the knuckle keelsons, which are 22 inches by 24 inches by 60 feet long.

The ordinary deck beams are 10 inches by 12 inches spaced 36-inch centers throughout and extend in one piece from guard to guard. The top timbers are 12 inches by 12 inches spaced 24 inches throughout, and the floor timbers 12 inches by 16 inches in one continuous length spaced 24-inch centers and fastened at the knuckle to the top timbers, which are notched 4 inches over the

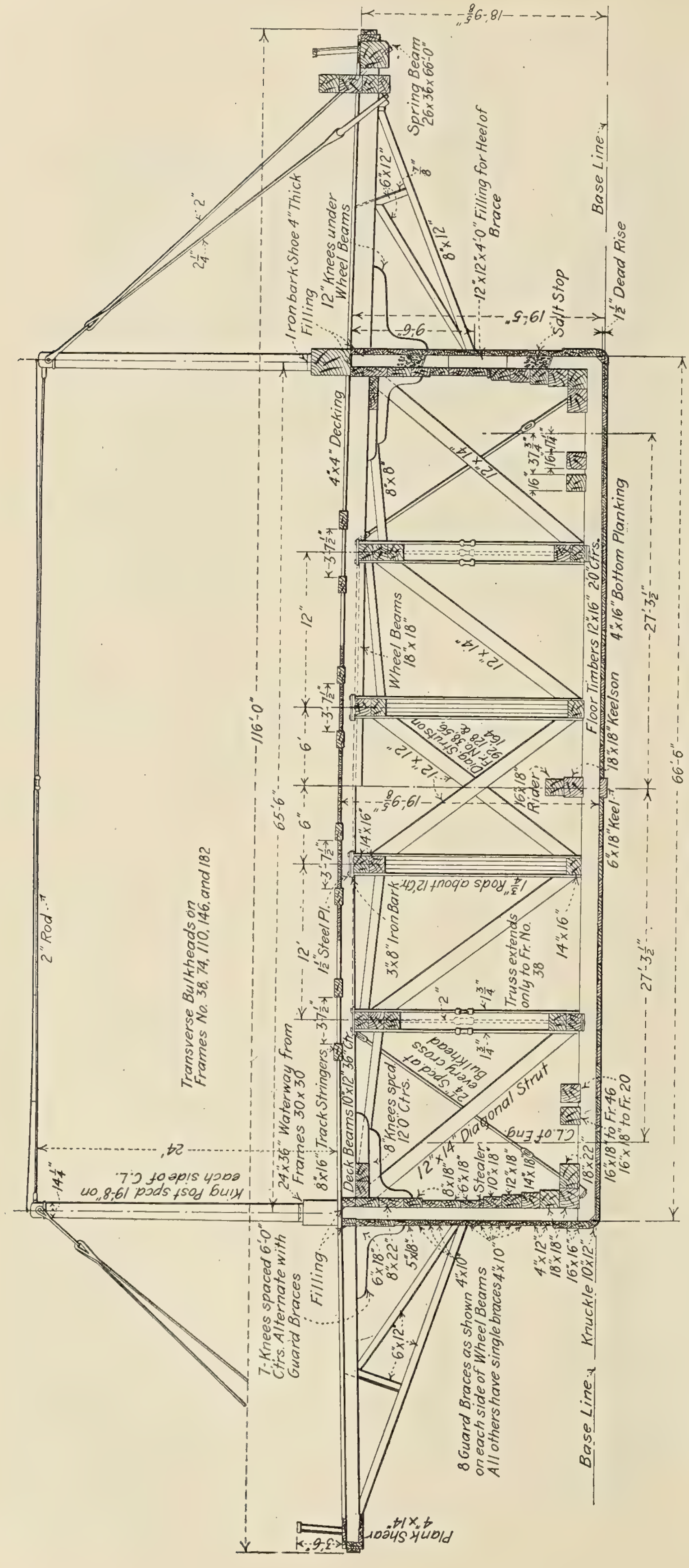


Fig. 8.—Midship Section of Contra Costa

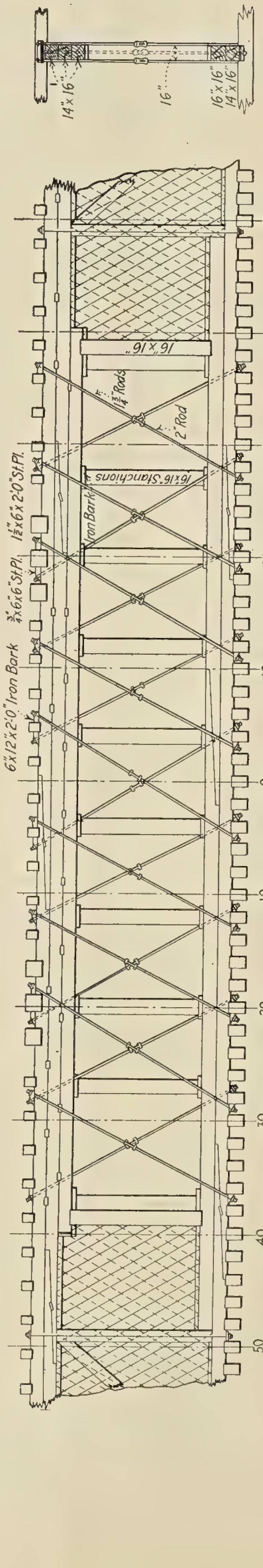


Fig. 9.—Truss in Longitudinal Bulkheads, Located 18 Feet from Centerline of the Ship

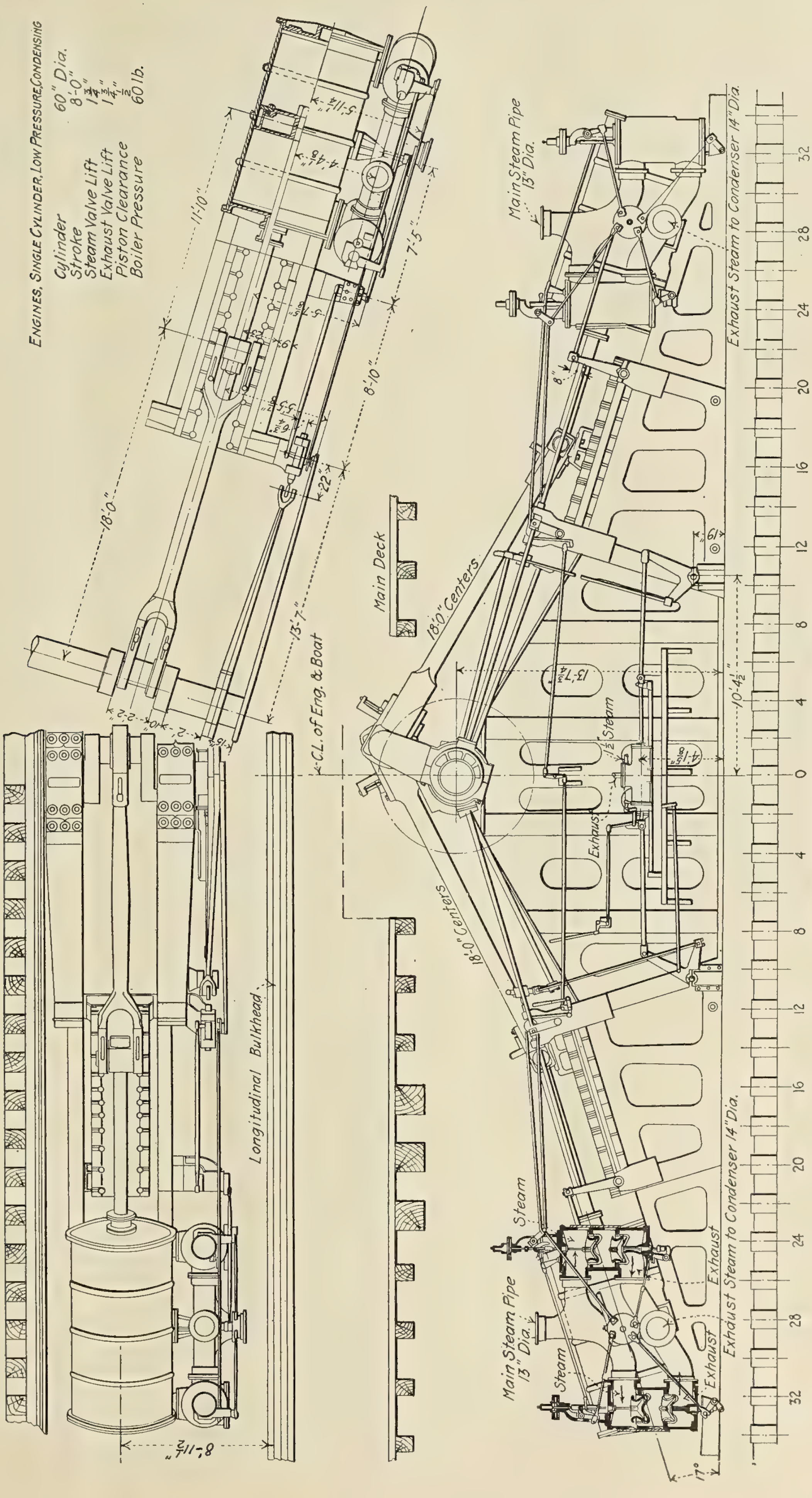


Fig. 10.—General Arrangement of Main Engines

floors and bolted together with two ⅞-inch bolts. The center keelson is 18 inches by 18 inches in lengths varying from 50 to 80 feet and is stiffened by a rider keelson 16 inches by 18 inches in lengths to break the scarphs of the center keelsons. The center keelsons are notched over the floor timbers 1 inch deep; the scarphs are 12 feet long with 4-inch nibs. Four fore and aft bulkheads extend from collision bulkhead to collision bulkhead, being spaced 12-foot centers and centering on the track centerlines. The hull is further subdivided into 11 watertight compartments by 10 cross bulkheads.

Ceiling

The ceiling represents some of the largest timbers in the boat and runs in diminishing sizes from the knuckle keelsons, which are 18 inches by 22 inches and 22 inches by 24 inches, varying in lengths from 60 to 80 feet to the two clamp strakes, 8 inches by 22 inches, under the deck beams. The ceiling is really the backbone of the hull and is a network of steel fastening running up and down, and through from the sides securing the heavy ceiling timbers to the top timbers and floors and to each other. The edge fastening is driven through the lower ceiling timbers and riveted over clinch rings on the outside of the floor timbers, but in the upper strakes the edge bolts are driven through three of the lower strakes and staggered at intervals of 3 feet. All fastenings in the lower heavier strakes are 1⅛-inches diameter, but in the upper lighter strakes the fastenings are reduced to 1-inch diameter. All drift bolts were driven and clinched with a Boyer air hammer, the holes being drilled 1/16 inch smaller than the bolt.

All scarphs in the ceiling were 12 feet long with 4-inch nibs and each fitted with two flat laurel keys 2 inches by 8 inches wide driven through the joint, instead of relying entirely on the steel edge fastening. The seams in the upper five strakes of ceiling have 2-inch by 8-inch flat laurel keys driven at about 8-foot centers.

As a means of preserving or "pickling" the lumber, two rows of salt stops are fitted between the top timbers in the space between the ceiling and outside planking and packed with 36 inches of "Liverpool" rock salt. About 80 tons of salt were used for this purpose.

Planking

The bottom planking is 4 inches by 16 inches fastened to floor timbers with three 7/16-inch by 7-inch spikes and one 1¼-inch diameter locust treenail, which is driven through each floor timber and wedged on both ends. All butts have composition spikes fastening.

The side planking consists of two strakes of 6-inch by 16-inch plank at the knuckle, but as it would be impractical to fasten through the knuckle keelson with treenails on account of the extreme lengths, short locust treenails were resorted to and wedged on the outside in the usual manner. The rest of the planking is 4 inches by 10 inches, and besides having the regular spike fastening is treenailed through the top timbers and ceiling with 1¼-inch diameter treenails, being in some cases 36 inches long. All treenails were driven with an air hammer. The sheer strakes consist of two strakes of 6 inches by 18 inches and one 5 inches by 18 inches, varying in lengths from 50 to 80 feet, and are bolted through top timbers and clamp strakes with 1-inch threaded bolts having flat, oval heads.

The guard, which extends around the hull of the ship, is of a rigid construction, the deck beams, as before mentioned, extending through the hull in one continuous piece. On the outside of the hull each alternate deck beam is fastened to the outside planking and sheer strake with 7-inch knees, which are fitted in place and dirft bolted through the planking, top timbers and ceiling. On the inside of the hull 8-inch knees are hung and fitted to the the deck beams at 12-foot intervals, being fastened to the same deck beams as the outside knees and taking the same fastening. The outer ends of the deck beams are covered with a 6-inch by 14½-inch Oregon pine facia, to which is fastened the regular 4-inch by 14-inch iron bark fender. Two strakes of 4-inch by 14-inch covering board on the top and bottom cover the ends of the deck beams. Filling blocks are fitted and fastened between the deck beams at the gunwale, as well as at the ends of the beams.

Each end of the boat has an apron pit 50 inches deep built into the transom, consisting of 14-inch by 18-inch timbers radiating from a common fantail beam located inside the hull and somewhat below the regular deck beams. This part of the boat is of particularly rigid construction, as it receives all the heavy pounding of locomotives and trains running on and off the boat. The bottom transom timber is 18 inches by 30 inches by 46 feet long, while the others are 18 inches by 24 inches. All stringers, keelsons, ceiling and fantail beams terminate at or are fastened to the transom with 1¼-inch diameter drift bolts through 10-inch, 14-inch and 16-inch knees. The outside of the transom, as well as around the nose of the boat, is pretty well covered with 1-inch by 8-inch steel plates to protect the wood from being marred by chafing against the heavy steel aprons.

Railway Tracks

The track stringers are of 8-inch by 16-inch Oregon pine notched 1½ inches over each deck beam and extend from transom to transom. To these stringers is fastened the 90-pound R.A. rail, which rests on 7/16-inch tie plates in much the same manner as in land practice. Tee-headed lag screws ¾-inch diameter are used to bolt the rails down, about 10,000 being used for this purpose. The tracks terminate on a 1½-inch by 12-inch steel plate which rests on 5-inch of iron bark 14 inches wide, which protects the softer wood in the transom timbers from the severe pounding of the trains. At the end of each track are two bumper blocks, which comprise a very simple though effective arrangement, consisting of 10-inch square Oregon pine blocks anchored across the rails and held in place by a steel collar and chains made fast to the eyebolts in the deck. To clear the tracks the deckhand slips the collar off the blocks and rolls it aside.

The seams of the bottom and sides as far up as the waterlines were calked with four threads of oakum and then cemented, the heavier strakes receiving 5 threads. Seams in the wake of the paddle wheel were puttied. Decking was calked with two threads with the intention of adding two more threads in a year or so after all fastening has pulled itself tight.

As may be expected, all the lumber was furnished under a very rigid set of specifications and considerable difficulty was experienced in procuring first-class ship's lumber of the quantity and dimensions required. The lumber was furnished by the Tacoma & Eastern Lumber Company, the Eastern and Western Lumber Company, of Washington, and the C. R. McCormick Lumber Company, of Oregon, and was, in the opinion of experts, very fine material.

While it is possible to design a more modern gear for controlling the rudders, the arrangement finally adopted can best be appreciated when the condition under which the boat operates is considered. As the straits across

which the boat operates is very narrow the tide runs like a millrace which is ever threatening to carry the boat towards the submerged rocks that line the shore. When this happens the rudders are sheered off like so much brush, and as it is almost impossible to tie up for more than a couple of hours at a time, some simple, efficient and inexpensive gear must be designed that can be replaced within a very limited time. There are four rudders at each end of the boat made of 4-inch Oregon pine planks with 5-inch diameter forged steel rudder stocks. The rudder stocks are shipped up through a bored cast iron sleeve, which is built into the hull, and are suspended from the top of this sleeve by a split clamp or collar fitted into a turned recess near the top of the rudder stock. To renew a rudder all that is necessary is to remove the tiller arm and split collar and let the disabled rudder and rudder stock drop overboard. A new rudder is then shipped up through the rudder stock sleeve and the split collar and tiller arm put on again, all of which can be done in 30 minutes.

Steering Engines

Hydraulic power is used for operating the steering engines, being supplied at 250 pounds pressure by two Knowles special 16-inch by 6-inch by 18-inch duplex pumps, one of which is a spare pump. The steering engine proper consists of an 8-inch single-acting cylinder with the usual leather cups, hydraulic piston packing, and is controlled from the pilot house by a horizontal lever directly connected to a 2-inch fourway plug cock. Fresh water is used, a 7,800-gallon tank being furnished for this purpose. The discharge is led back to this tank.

The boat also supplies the power that lowers the aprons in the slips, connections being made with the hydraulic line from the steering engine, which terminate in valve connections at each end of the boat and which are readily connected to a flexible line from the cylinders on the aprons operating them.

The aprons are heavy steel structures having four tracks, 12-foot centers, the same as the boat. They are 104 feet long, the shore end hinged and the other end floated on a pontoon 45 feet long, 25 feet wide by 11 feet deep. When not used the apron is always up, and to lower it requires but a clamp coupling and the turning of a valve, which is done by the deck hands on the boat and requires no attendant on the aprons whatever.

Propelling Machinery

The main engines operate independent paddle wheels on each side of the boat, each operated by a two-cylinder simple jet condensing engine 60 inches diameter by 8 feet stroke developing 3,000 indicated horsepower at 20 revolutions per minute with 60 pounds boiler pressure.

The cylinders are arranged one on each side of the wheel shaft, the line of motion being inclined 17 degrees with the horizontal. The connecting rods are 18-foot centers with strap gib and key ends; both rods connect with the same crank pin, one of the rods being forked for this purpose.

The valves are of the balanced poppet type, operated by a Corliss valve gear. The steam valves are controlled by an auxiliary cut-off of the releasing hook type, with an air-cushion dash pot on the top of the valve stem to prevent slamming of valves.

The reversing engine has a 9-inch cylinder 30-inch stroke and is located between the two reversing links. The connections are so arranged that when the engines are reversed one link is lowered and the other raised, thus taking advantage of balancing weights.

Although the engines and auxiliaries are located below the main deck, complete control is obtained from the engineers' stand on the main deck.

The engines, including the handling gear and condensers, were built at the Southern Pacific Company's railroad shops at Sacramento, Cal.

Boilers

There are eight Scotch dry back boilers 11 feet diameter by 13 feet long, in 4 units of two boilers each, with a total heating surface of 16,688 square feet. Each unit has a steam chimney superheater 94 inches outside diameter by 15 feet 6 inches long, with a corrugated flue 54 inches inside diameter. Each boiler has 276 3½-inch tubes and two Morison corrugated suspension furnaces

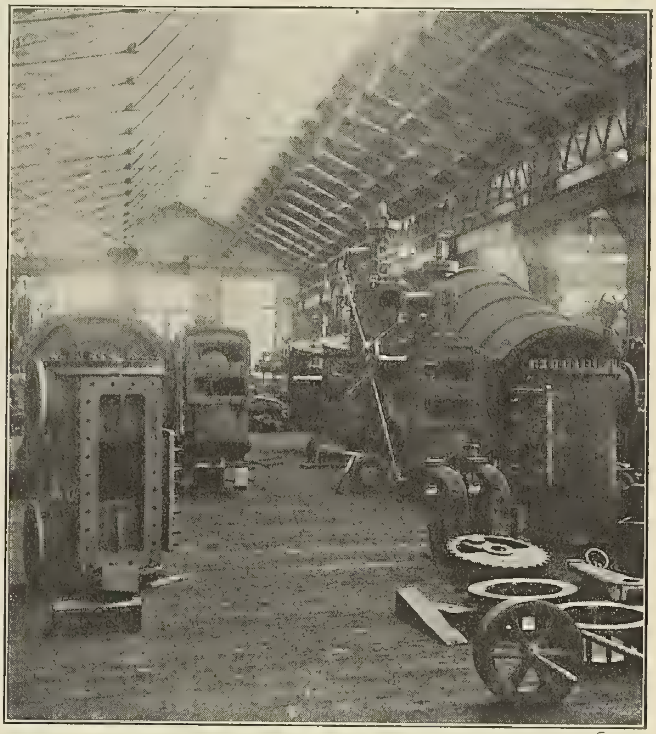


Fig. 11.—View of Main Engines, Being Assembled in the Southern Pacific Company's Shop at Sacramento

48 inches inside diameter. All boilers are located on the main deck on the guard nearly centering on the gunwale line, the two units on the same side of the boat being connected by a 19-inch main steam pipe; and as the boilers are about 100 feet apart the pipe line is made very flexible by swivel elbows at each boiler unit, which takes up all expansion and allows for all sagging or hogging to which the hull may be subjected without injury to the steam line. The boilers are equipped with a steam-atomizing oil-burner system, using a G. E. Witt burner.

Auxiliaries

The auxiliary equipment is very complete, consisting of 27 pumps, as follows:

Four 16-inch by 32-inch by 21-inch vertical single-acting twin beam air pumps.

Four 10-inch by 7-inch by 10-inch vertical duplex boiler feed pumps.

One 10-inch by 7-inch by 10-inch vertical duplex locomotive filling pump.

Four 6-inch by 4-inch by 6-inch vertical duplex oil pumps.

Eight 4½-inch by 2¾-inch by 4-inch vertical duplex boiler circulating pumps.

Two 14-inch by 8½-inch by 12-inch vertical duplex bilge pumps.

Two 14-inch by 8-inch by 12-inch horizontal duplex deck fire pumps.

Two 16-inch by 6-inch by 18-inch horizontal duplex steering engine pumps.

It is to be understood that the main engine, boilers and auxiliaries are in duplicate on each side of the boat—that is, each side of the boat has an entire independent steam plant. The air pumps are located on each side of a jet condenser and are of such size that either can maintain a vacuum of 19 inches, if for any reason one of the pumps should become disabled.

As the injection water is forced in by atmospheric pressure a 5-inch Dean vacuum breaker has been attached to the condenser to prevent the flooding of the condenser and endangering the engines, should both air pumps for any reason stop at the same time. The air pumps are controlled from the engineer's stand on the main deck. To simplify the piping the air pump discharges into a hotwell or "dump," consisting of a cast iron well 28 inches diameter and 9 feet high with a 12-inch outlet to the bottom of the boat. Although the boiler feed pumps are located in the hold complete control of them is obtained from the fireroom by manipulating the boiler check, the pumps being regulated by a Williams pressure regulator controlling the steam to the pumps by the pressure in the discharge line.

Each boiler is fitted with an independent boiler circulating pump, which is also connected to suction line of the inspirators and can thus be used as an auxiliary boiler feed. Each boiler has also a No. 50 stationary type Hancock inspirator.

The exhaust steam from the auxiliaries is utilized for heating the feed water, a Wainwright corrugated tube feed water heater being used for this purpose.

Fresh water for the galley and general purposes is supplied by gravity from two 2,000-gallon tanks located on the top of the superstructure.

Paddle Wheels

The paddle wheels are of the radial type, each with four cast steel wheel flanges of very light design keyed to a 20-inch diameter wheel shaft. The wheel is 28 feet diameter over buckets and has 3-foot, 4-inch dip when light-loaded. There are 20 buckets 3¾ inches by 28 inches wide by 16 feet long, which are bolted to the wheel arms with four ¾-inch stirrups. The arms are 4 inches by 15¾ inches of Oregon pine.

Current for all electrical requirements is furnished by two 25-kilowatt turbine generating sets located on the main deck. There is a 13-inch General Electric searchlight projector for each pilot house and the usual side lights, which are worked directly from the telltale board in the pilot house.

The main deck is illuminated with 20 vapor-proof 13-inch Crouse-Hinds Company reflectors. Six of these lights nearest the pilot house at either end are under the control of the pilot house.

The electric fixtures in the restaurant, bar and waiting rooms are equipped with XE Holophane reflectors. The engine and boiler rooms are equipped with vapor-proof conduits. Each of these rooms is wired in two circuits, the lights for the general lighting being alternated. At the steam gages and water glasses there are lights from each circuit, so that in case of a fuse blowing out in one circuit there will always be a light at these important points.

The compartments below deck, of which there are 45, are lighted by lamps placed in vapor-proof globes and in such compartments as have valves, steering gear, rudders, etc., there are watertight plug boxes. The engine and boiler rooms also have watertight plug boxes, which arrangement is such as to permit a number of portable lights.

There are four telephones, connected in multiple, from the pilot house to the engine rooms, also an electric call-bell system from pilot house to pilot house. There are also electric return calls for filling oil tanks for the purpose of signaling the attendant at the oil filling valves. Bell signals are always exchanged before filling the oil tanks to ascertain if everything is working properly, as the tanks might be flooded if bells should fail. There is also a push button at the side of the house at each quarter of the boat for man-overboard signals.

The electric fire-alarm system consists of 12-inch Faraday electric gongs in each engine room and directly under each pilot house. All wiring on this boat conforms to the National Electric Code standard rules.

Interior Views of the Great Northern

Passenger Accommodations of the Luxurious Steamers of the Great Northern Pacific Steamship Company

Supplementing the illustrated description of the design and construction of the 23-knot turbine-driven steamships *Great Northern* and *Northern Pacific*, published in our December, 1914, issue, we are now able, through the courtesy of the Great Northern Pacific Steamship Company, to publish in the following pages several views of the passenger accommodations of these magnificent vessels.

The *Great Northern* and *Northern Pacific* are sister ships, differing only in minor details. They were built by the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., and classed A-100 in accordance with the rules of British Lloyd's and also equipped to pass the laws now in force by the United States Steamboat Inspection Service. To recapitulate, the main particulars are: Length overall, 524 feet; length between perpendiculars, 500 feet; beam, 63 feet; depth, molded to A deck, 50 feet 8 inches; draft, full load, 21 feet; deadweight carrying capacity, 2,185 tons: shaft horsepower, 25,000; speed, 23 knots; passengers, first class 550, second class 108, third class 198; total passengers, 856; crew, 198; total number of persons on board, 1,054; gross tonnage, 8,255.

Few modern passenger ships of the same tonnage and type can boast of more commodious promenade decks or of more tastefully decorated or conveniently arranged public and private rooms. As can be seen from the photographs published in this issue, and from the plans previously published, these vessels are in every respect entitled to the popular designation of "floating palaces."

Fig. 1.—Corner of the Writing Room

Fig. 2.—Observation Parlor

Fig. 3.—Colonial Dining Room

Fig. 4.—Private Suite

Fig. 5.—Main Companionway

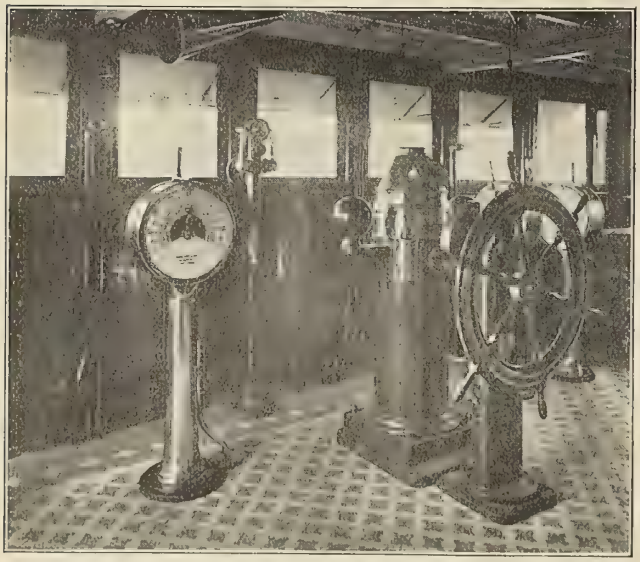


Fig. 6.—Wheel House

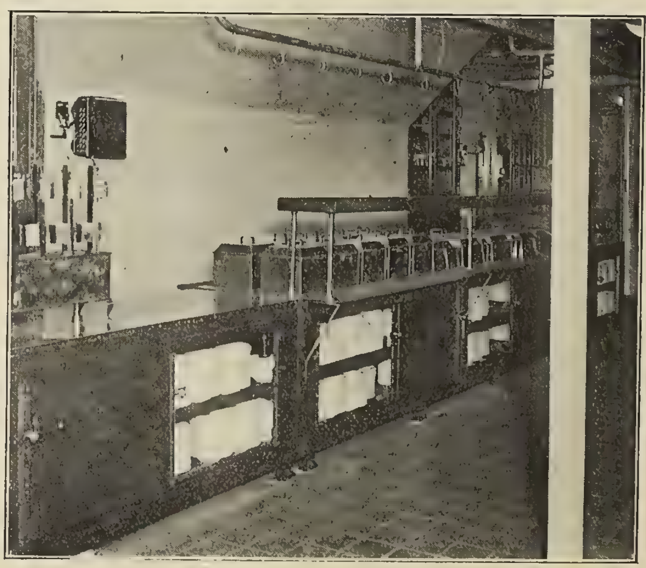


Fig. 7.—Pantry

Fig. 8.—Dancing on the Upper Deck

Fig. 9.—Glass Enclosed Promenade

Fig. 10.—Palm Garden Veranda

Fig. 11.—First Class Smoking Room

Modern Submarines in War and Peace—III

Early Development of the Submarine in Germany, France and Italy—Modifications of Original Inventions

BY SIMON LAKE *

Some incorrectly informed writers of books and magazine articles have, through their lack of complete information, given the credit of inventing and developing this seagoing type of submersible to the Krupps of Germany, to former Naval Constructor Laubeuf of France, or to former Naval Constructor Laurenti of Italy. For the purpose of giving a correct history of this development, perhaps I may be pardoned and not considered egotistical if I mention a few facts in connection with the development abroad of this type of boat.

On April 2, 1897, I applied for a patent on a combined surface and submarine vessel, the specifications of which began as follows:

"This invention relates to a *combined surface and submarine vessel* and may be employed either as a torpedo boat or for freight and general cruising purposes, or for submarine work of all kinds.

"It has for its object, first, to combine with a submarine vessel cylindrical in cross-section a superstructure built upon the submarine vessel and affording a large deck surface, buoyancy, and a high freeboard for surface navigation, the space between the submarine vessel and the superstructure being adapted to be filled with water when the vessel is submerged, and thus rendered capable of resisting the pressure of the water, etc. . . ."

A patent was granted in due course with fifty claims, and according to the records of patent offices throughout the world this is the pioneer patent covering this form of vessel.

When Krupps took up the matter of constructing submarines for the Russian and German governments, they took up this type of vessel as offering greater opportunity for development than the diving type. A contract was drawn with their directors for the construction of the "Lake" type of boat, which they accepted by wire. This contract covered their erecting a plant in Russia for the manufacture of "Lake" submarines on a division of profits and on a royalty basis in Germany. It also covered my employment by them in an advisory capacity. I was living abroad at the time and the papers were sent to my directors in America for their approval.

In the meantime I had submitted to them various plans of submarines, copies of my patents, and even my secret data, including copies of patents pending, all to enable them to go ahead, as I considered the agreement settled by their wire of acceptance. I had also advised them how

* Member of Institution of Naval Architects (England), Schiffbautechnische Gesellshaft (Germany), Society of Naval Architects and Marine Engineers (United States) and American Society of Mechanical Engineers.

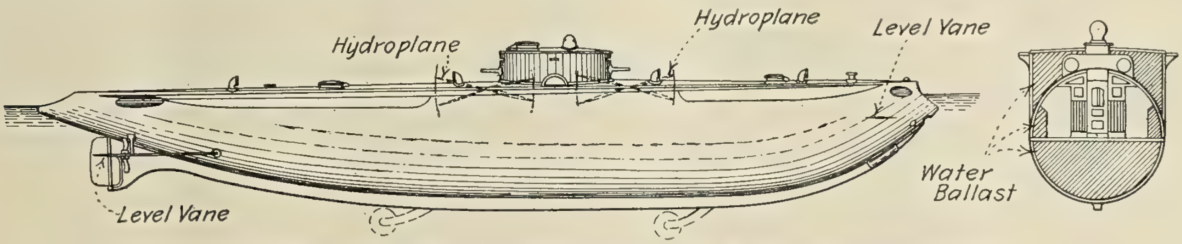


Fig. 24.—Plans of Lake Submarine, as Submitted to U. S. Navy Department in 1901

Mr. Lake's company built several vessels of this type for foreign governments and with slight modifications many of its general features have been adopted in the latest submarines in Germany, Italy, Russia, Austria and France.

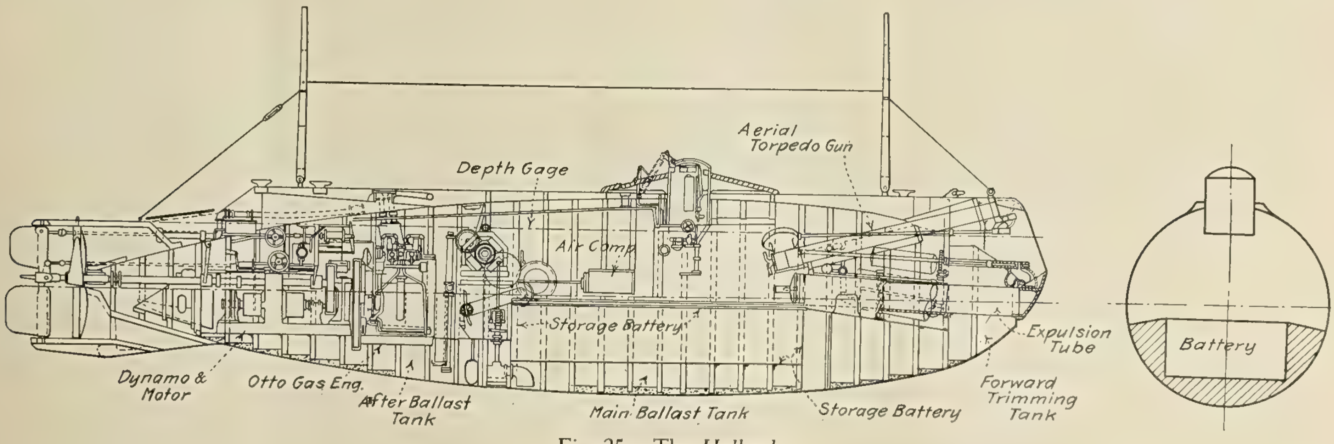


Fig. 25.—The *Holland*

This vessel, while holding to the same general principles of construction and method of control as used in the *Plunger*, was much better proportioned and had a much better distribution of weights. It was her performance that led the House Naval Committee in 1900 to authorize the construction of additional submarines of the Holland type. Her armament consisted of one torpedo tube forward and an aerial torpedo gun for firing aerial torpedoes, designed to be used somewhat on the same principles as used on the gunboat *Vesuvius*.

to overcome certain difficulties in boats which they then had under construction for the Russian Government at their Kiel plant, the Germania Werft.

Before I succeeded in getting the power of attorney from my directors in America authorizing me to sign up the agreement, the great industrial revolution started in Russia (immediately after the Russo-Japanese war) and the Krupps informed me that, owing to that fact, they had reconsidered their idea of going into Russia and withdrew from the arrangement. Their attorney there informed me that on looking up the patent situation they found that "I had not protected myself in Germany and that they were free to build 'Lake type' boats in Germany and expected to continue to do so."

This was true, for, like most pioneer inventors, I had not succeeded in securing sufficient capital to finance and protect my fundamental inventions in all countries, which would have involved very large amounts in taking them out and paying the yearly tax.

So much for Germany.

The Conference in Rome

In 1905, while residing in Berlin, Germany, I was called to Rome and sat three days with a commission appointed by Admiral Mirabello, at that time Italian Minister of Marine, regarding their construction of submarines. I then learned that the Italian Government had started on a plan of building submarines of substantially my type, that they had several under construction at their Venice Arsenal after the design of Major Laurenti, a naval constructor, that certain difficulties which they explained to me had arisen, and that they had not succeeded in getting any of their boats to function satisfactorily submerged. I came to the conclusion that their trouble was due to lack of longitudinal stability and advised the Commission how to increase this, and shortly afterwards I was advised that they had corrected their trouble and that the boats there worked satisfactorily.

Major Laurenti, at this time, resigned from the Italian navy and became affiliated with the Fiat Company, and has designed quite a large number of successful submarine boats, all of which have buoyant superstructures and are designed to operate on a level keel by the use of hydroplanes. These boats are of the "Lake type" as far as invention goes.

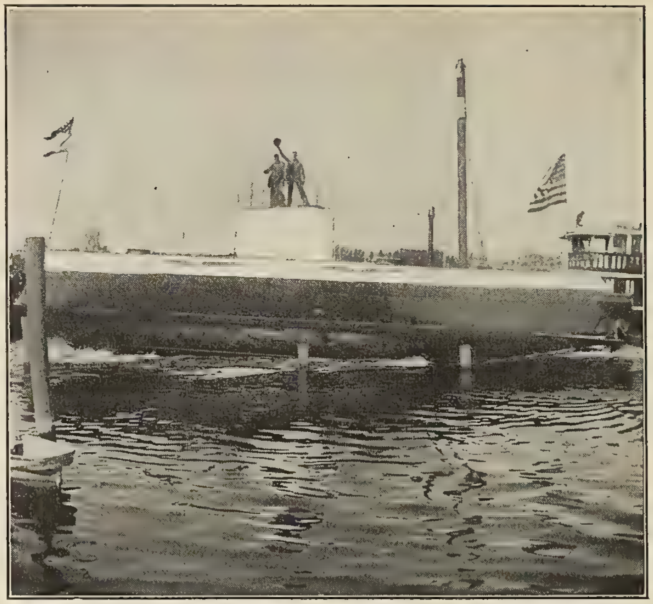


Fig. 27.—Launch of the *Protector*. Built in Bridgeport, Conn., in 1901-1902, Now in Vladivostock, Russia

There is a difference, however, between invention and design. Invention introduces a new method, new principle, or a new form of construction, to accomplish a certain purpose in a new way. Many modifications of design may be made which do not involve invention.

As an illustration, on August 14, 1907, Major Laurenti applied for a United States patent on a submarine or submersible boat in which the attempt was made to secure a patent on slight variations of design over the "Lake type." The patent office records show that many amendments were made and hearings held in the endeavor to evade the foundation patent of Lake, No. 650,758, which was applied for April 2, 1897, over ten years before Laurenti applied for a patent. The patent office consistently and persistently held that the slight difference in design did not involve invention over "Lake."

After arguments and hearings, extending over a period of over three years, Major Laurenti was finally obliged to accept a patent restricted to details of construction, most of which were in themselves not new to me, as they had

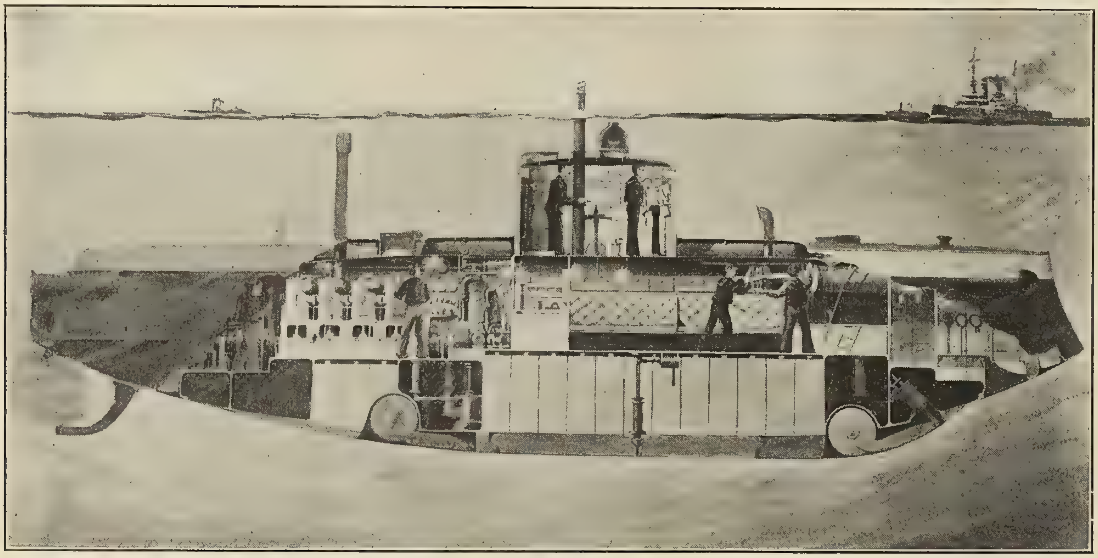


Fig. 26.—The *Protector* (Lake Type, 1901-1902)

already been used in various modifications of my inventions and consisted in such changes as would naturally be worked out by any good hull or engine draftsmen while developing the designs of a vessel.

Our patent laws are too free in allowing the grant of over 1,100 claims covering a few fundamental inventions, some of which cover details of construction for which I should not have been forced to seek protection.

All original inventors complain of this system. I know of several instances where patents on modifications of

Fig. 28.—The *Protector* Running, in Condition for Instant Submergence

Her conning tower is being held partly above the surface by her "hydroplanes" being "set" so as to "lift" instead of submerge. This photograph shows the remarkable steadiness and reliability of this early hydroplane level keel boat and the confidence of her crew in navigating in this manner.

patents on modifications of design while fundamental patents are still in force. This works great hardship on original inventors, forcing them to take out a great many patents on features of design rather than on invention. I have taken out nearly 100 United States patents with design have been granted, which modifications have been in common use for several years by others, but were only considered as a design and not as an invention. Then some designer hits on the same arrangement and considers he has made an invention and applies for and takes out a

Fig. 29.—The *Protector* Running in Long Island Sound in 1902 in Rough Weather

patent which has already been in common use but has been looked upon purely as a design by its originator rather than an invention. Then the original designer may be hauled up before the courts and put to great expense to prove that it was in prior use as a design.

While Captain Laubeuf and the Krupps have taken out several patents on detail mechanisms for use on submarine boats, they have never, as far as the author is aware and the public patent records show, attempted to claim to be the original inventors of the type of submarine with buoyant ship-shaped form of hull consisting of a pressure resisting body surmounted by a watertight non-pressure resisting body which gives suitable form for surface speed and seaworthiness, which is the principal characteristic of vessels built by them. I feel, therefore, that certain misinformed authors should, in the interest of fact, correct their statements if they issue new editions of their work or write further on the development of the submarine.

During the years of practical experimental work with the *Argonaut,* Mr. Holland continued in his efforts to get the *Plunger* (building under the 1893 appropriation) in shape for submerged trials, but without success.

Why the Plunger Failed

The large steam installation, 1,600 horsepower, was largely responsible for this. As I remember, there was only about 18 inches between the main engines, with large steam supply and exhaust pipes overhead and under foot. These engines were designed to run at over 400 revolutions per minute. The boiler was located nearly in the center of the vessel and so nearly filled the ship that there was barely room between the top of the boiler and ship to creep from "forward to aft."

The heat was so intense that the trial crew found it impossible to live in the boat, so, for their full power dock trials, valve stems were run up through the deck to enable the engines to be started from there. Arrangements were also made to take the indicator cards from the deck.

She was also fitted with a heavy armored conning tower, as per Mr. Holland's description previously quoted. This combined with the high position of the boiler and engines, combined with her cigar-shaped form (which gives a diminishing water plane), reduced her stability almost to zero. I was informed when the attempt was first made to start up one of her engines, her stability was so little that the turning effort on her propeller shaft nearly caused her to "turn turtle," and that she rolled over on her side to such an extent that the conning tower struck the dock stringer. The constructor at the Columbian Iron Works then put heavy chains on her so she could not turn over.

Every inducement was made to the Holland Company to enable them to make this vessel satisfactory, as Congress in 1896 authorized the Secretary of the Navy to contract for two more "submarine torpedo boats of the Holland type, *Provided* that the Holland boat now being built for the Department shall be accepted by the Department as fulfilling all the requirements of the Contract."

She was finally abandoned in 1900 without ever making a submerged run or fulfilling any of her guarantees of performance under which the award was secured.

Mr. Holland as early as 1897 must have concluded that the *Plunger* was destined to failure. In fact, no submarine, even up to the present day, has ever equaled the performances guaranteed under the *Plunger's* contract. He therefore built a much smaller boat, called the *Holland.* This vessel was fitted with internal combustion engines instead of steam, and was finally accepted by the United States Government in lieu of the *Plunger,* and placed in commission in 1900.

She was the first submarine torpedo boat to go into commission in the United States Navy. Her characteristics were: Length, 53 feet 4 inches; beam, 10 feet 3 inches; displacement, 64 tons surface, 75 tons submerged; power, internal combustion engines, 50 horsepower; surface speed, 6 to 7 knots, claimed; submerged speed, 5 knots claimed. The only official report I have seen gave her a surface speed of 5⅔ knots. I believe she was purchased by the authority of the Act of June 7, 1900, which read as follows:

> "The Secretary of the Navy is hereby authorized and directed to contract for five submarine torpedo boats of the Holland type of the most improved design, at a price not to exceed one hundred and seventy thousand dollars (£35,000) each: Provided, That such boats shall be similar in dimensions to the proposed new *Holland,* plans and specifications of which were submitted to the Navy Department by the Holland Torpedo Boat Company, November twenty-third, eighteen hundred and ninety-nine."

The United States was, therefore, at the beginning of the twentieth century, fairly launched on a policy of submarine boat construction, and other governments rapidly followed suit. France had, in the meantime, brought out two new boats, the *Morse,* 1898, and the *Narval,* after the designs of M. Laubeuf, launched October 26, 1899. The *Gustave Zede* had also been modified by adding hydroplanes so that she became controllable submerged.

The *Morse* was 118 feet long by 8 feet 3 inches beam, with a displacement of 136 tons of about the same type as the *Gustave Zede.* The *Narval* was 111 feet 6 inches in length by 12 feet 4 inches beam, 106 tons surface displacement and 168 tons submerged. She was, like the author's 1893 design, a double hull vessel controlled by hydroplanes. She was fitted with "Drezewiecke" apparatus for carrying and discharging torpedoes, two of which were carried on either side.

First French "Submersible"

The *Narval* was a successful type and appears to have been the first French naval vessel to adopt a shipshape outer hull of lighter plating. She was also, as far as my records show, the first French boat to be fitted with two motive powers, viz., steam for surface work and electricity for submerged work. To distinguish her in these particulars from the purely electric boats of cigar-shaped form, like the *Gustave Zede* and *Morse,* Mr. Laubeuf called her a submersible.

Very little was known about the French boats at this time (1900), as their method of construction and experiments were kept secret, but enough information leaked out as to their reported success to cause the British public much uneasiness and they began to demand that their Admiralty should also take up the development of the submarine. No one had, so far, evolved a satisfactory type in England, so when the fact became known that the United States Congress had made an appropriation for five *Holland* boats, the British public became still more insistent that they should also have submarines.

About this time, so the author was informed by Sir William White, who was then chief constructor of the British Navy, Lord Rothschild brought to him Mr. Isaac L. Rice, president of the Electric Boat Company, who controlled the Holland patents and who offered to build duplicates of the United States boats for England. Sir William thought this gave the Admiralty the opportunity to satisfy the public demands and to meet the French, their hereditary enemy (this was before the establishment of the "Entente Cordial"), in their development of the submarine, consequently an arrangement was made for the manufacture of this type of vessel for England by the Vickers

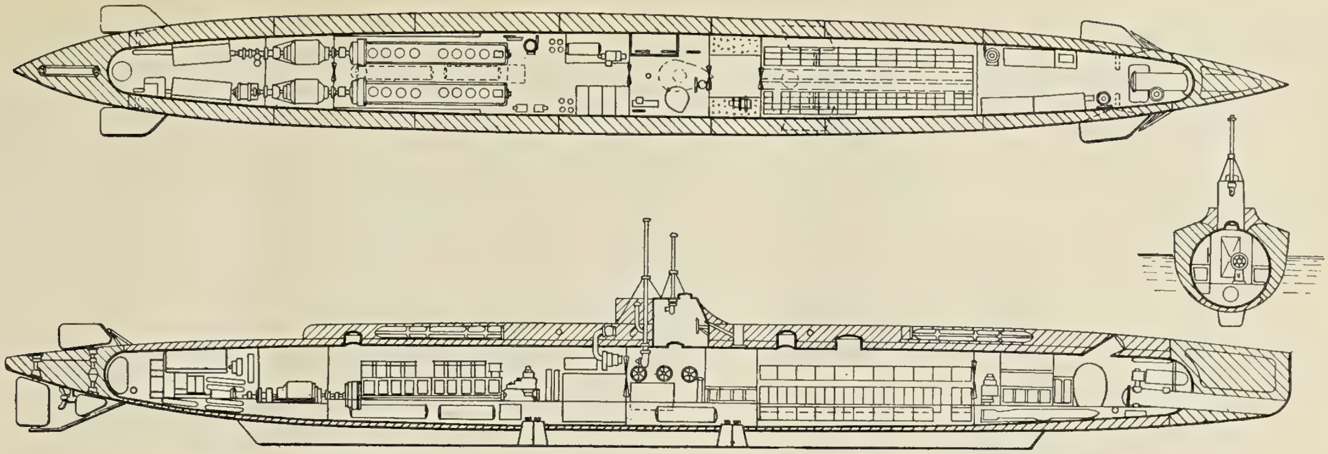


Fig. 30.—Modern French Submarine of Laubeuf Design, Constructed by Schneider and Company

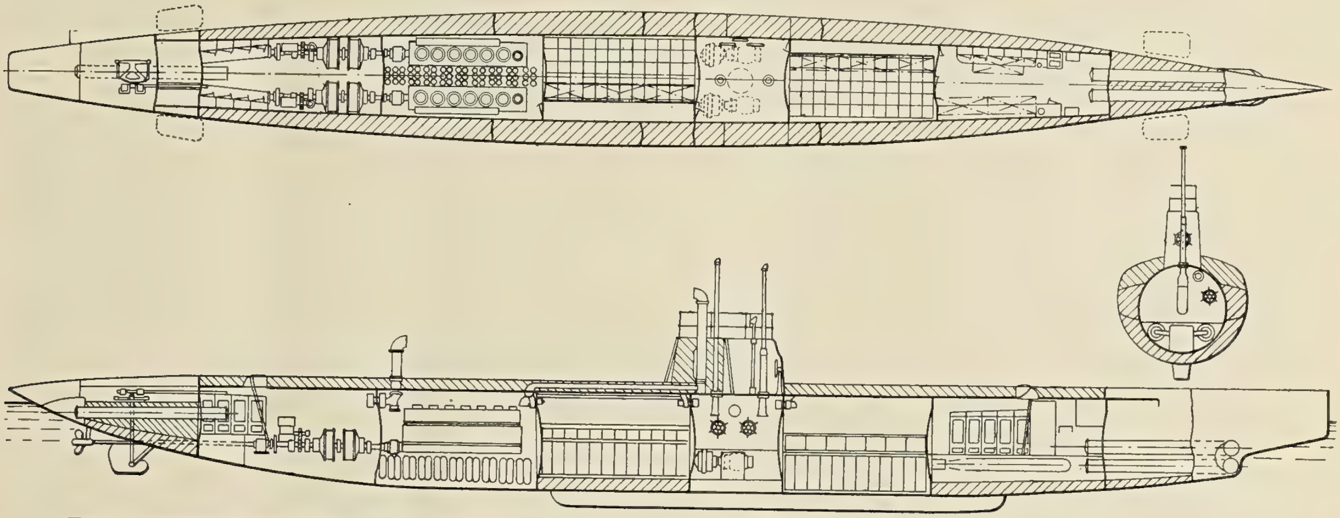


Fig. 31.—Modern Italian Submarine—Fiat Construction—Laurenti Design. Vessel of the Double Hull Buoyant Superstructure, Hydroplane Controlled Type

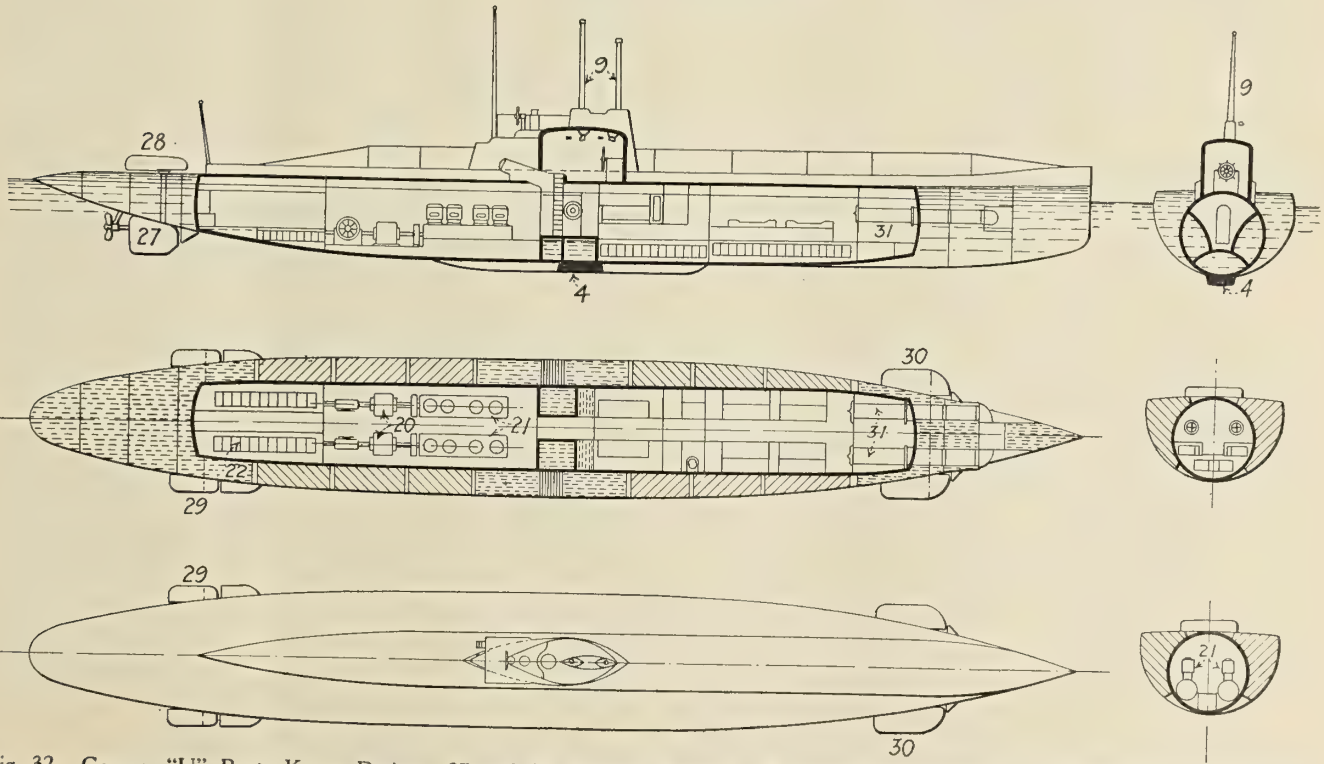


Fig. 32.—German "U" Boat—Krupp Design. 27 and 28, Vertical Rudders; 29 and 30, Hydroplanes for Controlling Depth of Submergence; 9, Periscopes; 21, Engines; 20, Motors; 22, Storage Batteries; 4, Drop Keel; 31, Torpedo Tubes

Company and an agreement was drawn, so he informed me, giving "Vickers" an exclusive monopoly of building submarines for the British Navy for a period of ten years, the consideration being that they should have available for the use of the British Admiralty all the details of the development work of the Electric Boat Company in America. This, plus their own experience and development work in England, which should be kept secret, should enable them (England) to keep on an equal footing with France.

Sir William informed me that he thought this had been a mistake in policy, as it had deprived the government of the opportunity to secure improvements that had been developed by other inventors and builders who had made greater progress on independent lines.

England, therefore, started to build her first submarines, known as the "A" type. These were practically duplicates of the United States *Adder* and *Moccasin* type, now also designated as "A's" Nos. 1 to 7. England has been particularly unfortunate with this class of submarine, several of them having plunged to the bottom with the loss of their crews.

The majority of the British and American boats are developments from the original *Holland* of Mr. Holland's design. Increasing the stability, greater subdivision of ballast compartments, refinements in steering gear, and the addition of hydroplanes forward have enabled Mr. Holland and his successors to produce submarines that operate very well. These boats, however, with only one pair of forward planes, still require constant manipulation of the horizontal rudder to control them when submerged. This rudder, controlled by power gear, is very effective and will, by expert manipulation, hold the submarine to practically even depth, the only danger the writer can see is that the diving rudder gear might fail to function after it is set in the diving position, in which case the vessel might continue diving until she struck bottom or reached a depth great enough to cause her to collapse.

The modern submarine, therefore, as built and used in all the world's navies, owe their final success to principles of construction and control devices invented and introduced into the art by two American inventors.

(To be continued.)

Notes on the Conversion of Cargo Vessels into Bulk Oil Carriers—VI

BY F. K. RUPRECHT *

Pumping Systems

The oil pumping lines and ballast lines must not be connected in any way. No ballast pipes will pass through oil compartments, nor shall oil pipes be led through the engine or boiler rooms; that is, the oil system for the forward part of the vessel will be entirely independent of that for the after part.

A 10-inch or more diameter lap-welded steel pipe will be fitted on each side of the centerline bulkhead throughout the tanks and cofferdams. Eight-inch suctions with bell mouths will be led from this pipe at the after end of each tank and cofferdam. These bell mouths will be clear of the bottom plating by about ½ inch. Limber holes will be cut in all floors and in the margin plate to allow the oil to flow to the suctions. An 8-inch diameter crossover pipe will be fitted in each tank and cofferdam connecting the two main lines. This enables any tank to be pumped through any line. A 10-inch master valve will be fitted just forward of the bulkhead in each tank and an 8-inch valve on the suction pipe and another on the crossover pipe. The stems of these valves will be led up to the upper or weather deck, where they will be fitted with hand wheels. If necessary, bevel gears and brackets will be fitted to valve stems to clear hatches or other obstructions. A bushing will be provided at the tank deck and an oiltight stuffing box at the upper deck. If the stems pass through the shelter deck, a watertight stuffing box will be fitted. All these valves will be double-seated gate valves with a stationary stem.

On the 10-inch main line an expansion joint will be fitted in each tank. Where these pipes pass through the bulkheads oiltight fittings will be installed. These will usually be the shipyard's own standard. The two main lines will lead into a suction and discharge manifold in each pump room where two independent horizontal steam pumps will be installed. One of these will be about a 14-inch by 12-inch by 14-inch and the other an 8-inch by 6-inch by 8-inch. The piping will be so arranged that either pump may be used for any purpose. A filter will be installed in duplicate and piping arranged so that oil can be filtered when discharging or loading. A by-pass will be arranged so that the filters may be cut out. The main sea valves for ballast will be fitted in the cofferdams under the pump room flat and they will be operated from there.

The discharge piping will lead to the weather deck and will be arranged to discharge on either side of the vessel. A line will be fitted along the deck from the discharge line of the after pump room to that of the forward, so that cargo may be discharged from the most convenient place. This connecting line is best made portable, or its tightness may be impaired or the flanges broken by the movement of the vessel amidships when in a seaway.

The steam lines will be led from the main and auxiliary boilers to each pump in the pump rooms, and the exhaust lines will be led to the main and auxiliary condensers or to the steam exhaust tank. A deck connection must be arranged so that shore steam can be used.

A small steam pump will have to be installed forward to pump out the forward dry hold and the peak tank. A connection should also be made to the forward cofferdam to take care of the water ballast in this space. A sea valve and a discharge connection will be fitted to the ship's side. The most convenient location for this pump will be on the top of the peak tank. The steam will be taken from the deck steam line to the windlass and the exhaust will be through this same system.

In most cases it will be found advisable to install a similar pump in the after end of the tunnel to take care of the water in the tunnel, after dry hold and peak tank and the ballast in the cofferdam. A sea valve and overboard discharge must be provided for this pump. The steam will be taken from the deck line through the after access trunk. In some cases the tunnel, dry hold and peak tank may be handled by the ballast pumps in the engine room through old ballast lines to these compartments through the tunnel. This arrangement will usually be passed by the registration societies, but the former is the better.

If the 'tween decks are used as summer tanks, sluice valves must be arranged to allow the oil to drain into the main tanks for pumping. Sometimes an independent pumping system is provided, but in any case provisions must be made for filling them.

Engine and boiler room bilge and ballast systems will be retained and arranged to suit the new conditions.

* Associate Member Society of Naval Architects and Marine Engineers.

If the 'tween deck spaces are used for cargo or coal, arrangements will be made for pumping them by means of a hand pump on the upper deck. Rose boxes will be fitted in each compartment with a pipe to the upper deck suction manifold which will be connected to the pump suction chamber.

A sounding pipe will be provided in each tank and cofferdam. These pipes will be run up to a height of 12 inches above the upper deck and be fitted with a brass-screwed plug, properly engraved. If desired, these pipes may be carried up to the shelter deck, where a deck plate will be fitted.

Steaming Out Arrangements

Arrangements must be made for steaming out the tanks and cofferdams for cleaning or in case of fire. This is best made a permanent system because a hose line may fail just when needed and is always a source of trouble. The best arrangement is to provide a special steam line from the boilers run along the weather deck with connections to each tank, cofferdam and pump room through the deck or hatch coaming. A quick opening gate valve operated by a lever will be fitted at each branch on the top deck, so that filling a tank with steam is only the work of a few seconds.

Gas Pipes

A copper pipe will be led from the coaming of each oil hatch and cofferdam hatch to a main line running along the upper deck. This line will be carried up each mast to a height clear of the running lights to form a gas and vapor escape, and to prevent a partial vacuum being formed in any tank while pumping before the hatches are opened up. The top of this pipe is to be covered with fine wire gauze.

Ventilation

Each side of the cofferdams will be ventilated by a cowl ventilator covered with fine wire gauze to prevent fire. These ventilators must be arranged to act both as a downtake and up-take.

The pump rooms will be ventilated as noted under that heading.

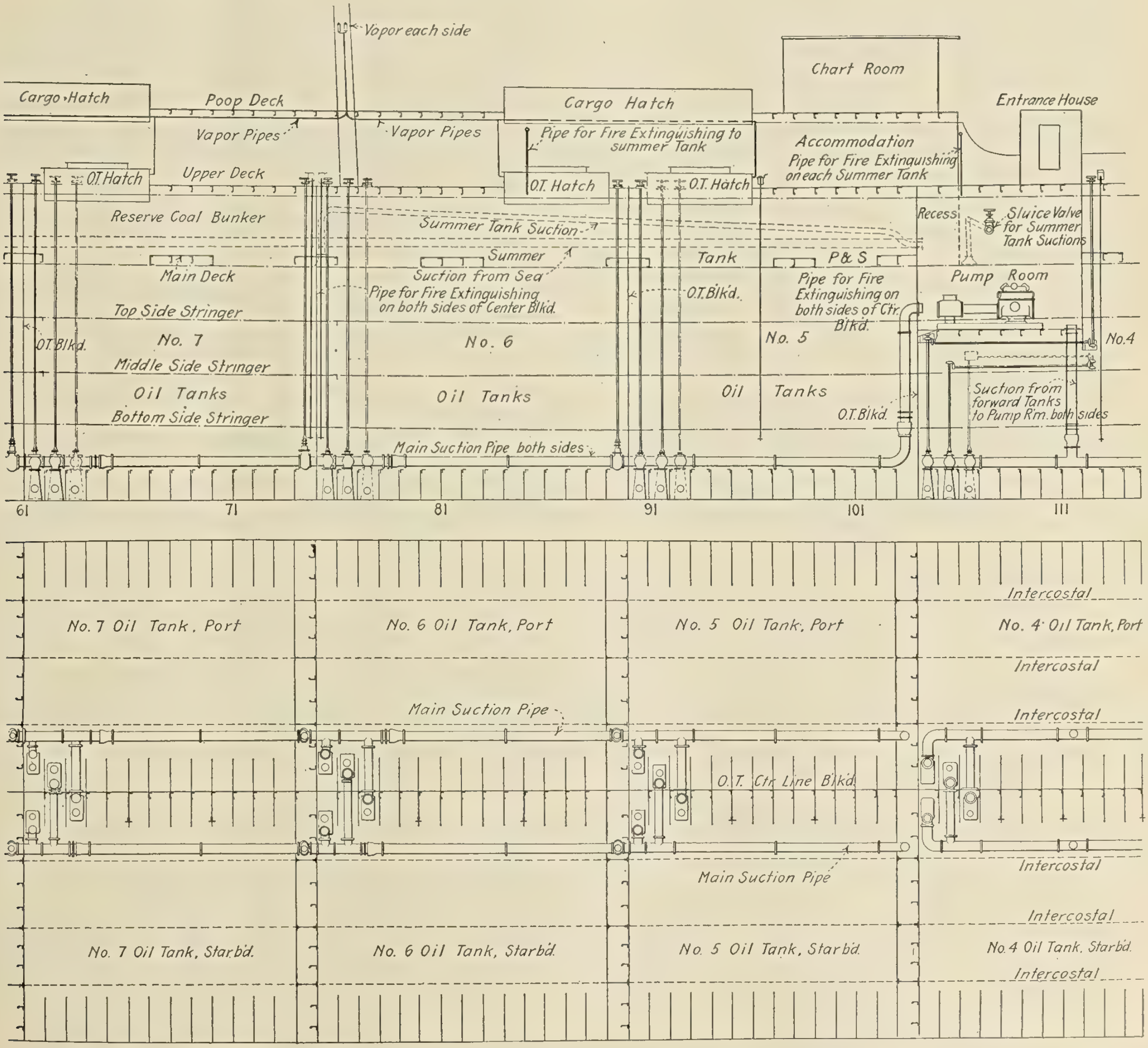


Fig. 18.—Arrangement of Main Cargo Pump Lines in Tanks

The tunnel will be ventilated through the access trunks, the foremost one being fitted with down-take cowl and after one with an up-take cowl.

The forward and after dry holds will be ventilated by the ordinary means, and the 'tween decks alongside of the expansion trunk, if used as coal bunkers, must also be fitted with ventilators. In this case a down-take ventilator will be fitted at the forward end of each compartment and an up-take at the after end. These ventilators must in all cases be capable of battening down watertight.

In a shelter deck vessel it is very advisable to build gas-tight trunks around the oil hatches on the upper deck. In this way the entire shelter 'tween decks are kept clear of dangerous gases. This 'tween decks space outside of the trunks will be ventilated by the ventilators as already fitted in the vessel. This space outside of the trunks can be used for coal on long voyages.

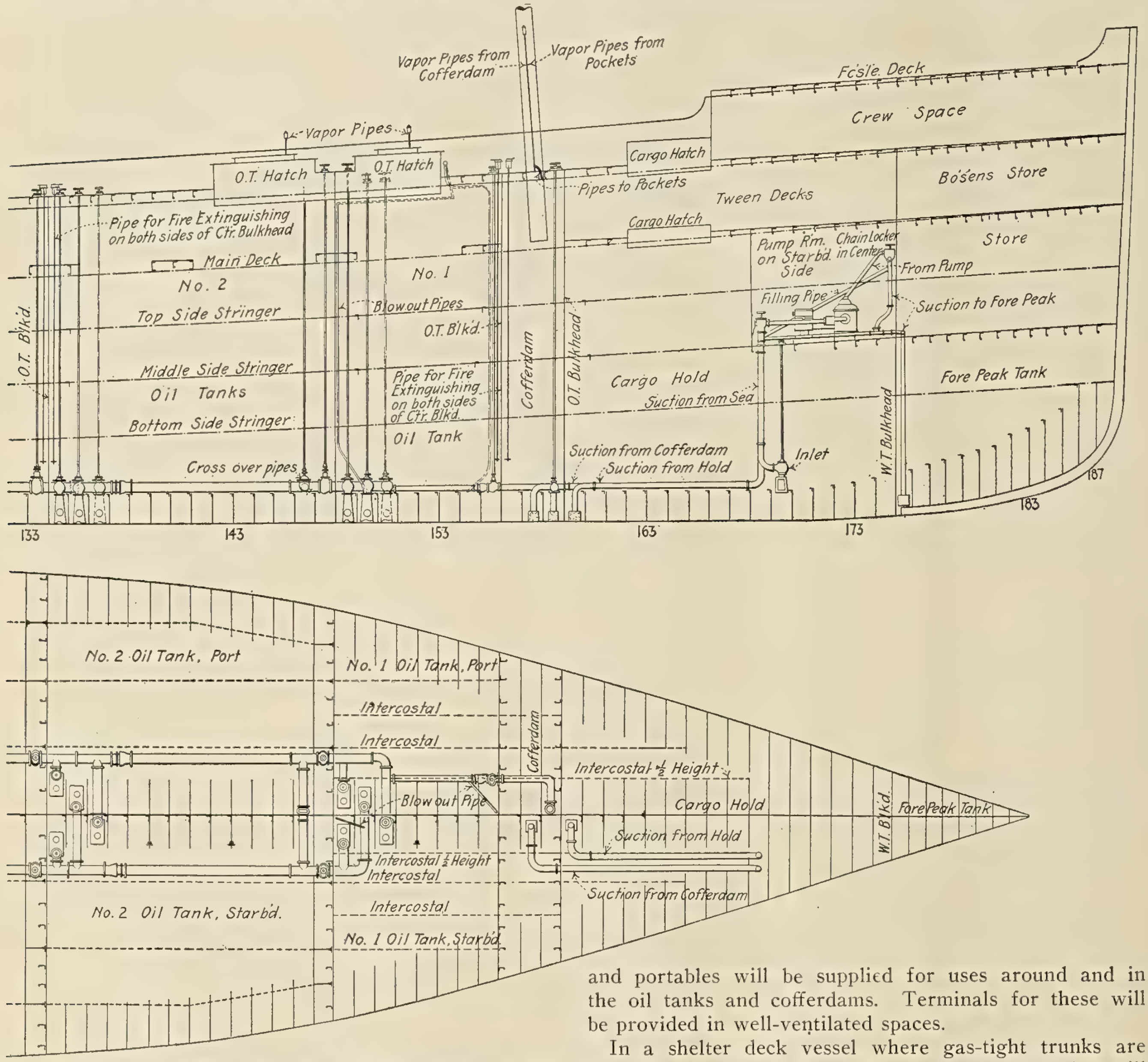


Fig. 19.—Arrangement of Auxiliary Pump in Forward Part of Ship

Electric Lights

If a dynamo is not already installed in the vessel, one of ample capacity should be installed. Only continuous current machines are permitted in oil boats. The old system will have to be rearranged and new additions added. Since these additions will test the total capacity of the machine, a duplicate generator should be installed.

All wire should be carried in conduits to the weather and distributed from there along the deck in watertight conduits. No fuses or switches should be fitted below the deck except in the accommodation spaces. No parts liable to spark are to be fitted in the pump rooms or in any other spaces where fumes are apt to collect. Clusters and portables will be supplied for uses around and in the oil tanks and cofferdams. Terminals for these will be provided in well-ventilated spaces.

In a shelter deck vessel where gas-tight trunks are fitted in the shelter 'tween decks, permanent lights will have to be installed in the spaces outside of these trunks.

Permanent lights in the pump rooms and tunnel will be enclosed in glass globes and wired guards.

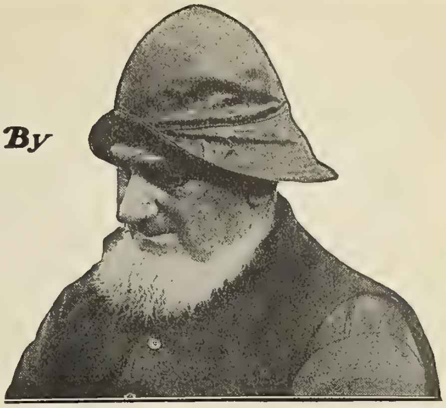
Testing

Each tank, pump room and cofferdam will be tested by a head of water as prescribed by Lloyds.

It will be advisable to fill the tanks with water ballast and run the vessel at sea for at least six hours. In this way the tunnel and cofferdam bulkheads would be tested under actual sea conditions.

Only such spaces as used for oil fuel need be calibrated. This is done by filling the tanks from tanks of known capacity. Curves will be plotted showing the capacity of the tank at any given sounding, and in this way accurate figures for fuel consumption are obtained.

Economy Talks By "Old Scotch"



"Watch Your Pistons!"

In our last number I paid my respects to our old friend "brass," but the joke is on me, I'll have to admit. Shortly after I wrote it I went out on the trial trip of a new vessel, and the lack of a little brass nearly got us into serious trouble. The throttle valve was made of cast steel, and the valve stem, of course, was of wrought steel. At the end of the full speed trial it became necessary to slow down by shutting off the throttle. Try our best, we couldn't turn the 24-inch hand wheel, not even with the additional leverage of a big monkey wrench on the rim of the hand wheel worked by two husky men. Nothing doing—no open, no shut!

Of course we had to work into the dock by putting a man in the upper fireroom, who opened and closed the main stop valve in order to answer the bells from the bridge. When the engine was cooled down another attempt failed to turn the "durned" thing. Still nothing doing. We finally had to take off the throttle valve cover and take the valve disk, stem and cover up to the machine shop. Even with the facilities there that blooming stem wouldn't turn one way or the other. As a last resort we cut off the 1¾-inch stem close up to the stuffing box and then drilled it out. What had happened, you will naturally ask?

The answer is simple. The stuffing box was cast of steel with the cover, and the guide was bored out almost to a fit. Some hard scale from the inside of the casting had worked in between the stuffing box guide and the valve stem, with the result that the wrought steel stem working on the cast steel guide with a few flinty chips or scale for a lubricant had galled. It was easily remedied, of course, by boring out the steel guide and fitting a small neck bushing of brass, so that now we have a new wrought steel valve stem working on the brass bushing, and a child can turn the hand wheel—all of which shows that some brass is mighty good in some places about an engine.

Of course the man who designed the valve knew that steel does not work well on steel, but it was one of those thousands of little details about marine machinery which, unfortunately, he had overlooked.

An old Scotch shipmate of mine used to say:

"Iron on iron works vera fine,
But steel on steel works nae so weel,"

and that brings up a branch of marine economy that I have somehow overlooked, and that is the keeping of pistons tight. Of course steam cylinders always have been and always will be made of cast iron. Pistons nowadays are made generally of cast steel, and, as everyone knows, that material does not work very well on cast iron, so we have to use cast iron packing rings to keep the pistons tight.

But even so, do they keep them tight? I'll venture to say that about half of all steam pistons leak to a greater or less extent, and there's where many a dollar is wasted.

A besetting fault of nearly all marine engineers is that they do not test their engines often enough to detect leakage of this kind. Putting on the indicator and taking a few cards is too much trouble, they say. Of course that will detect large leakages, but a much quicker way is to put the piston on the top of the stroke, turn steam on and then open the bottom indicator cock or cylinder drain. If there is any leakage of steam by the piston it is bound to show up in this test, and, believe me, it will show up in a great many instances. Some engineers will argue that it does not make much difference, anyhow, as what leaks through the high-pressure piston will do some work in the intermediate, and so on. But suppose your low-pressure piston leaks; or suppose, as is often the case, all your pistons leak? In the auxiliaries the leaks are sometimes pretty bad, but they do not amount to so much, on account of the smaller quantity of steam that is used in them.

Now I do not propose to say that I know of any particular kind of piston packing that will keep them absolutely tight. There are probably a dozen different patented devices for packing pistons, some of them very efficient, some of them not very good. In any event it pays to watch them, and as soon as they begin to leak put in new ones. I know one tugboat that has a 10-inch high-pressure cylinder where an ordinary snap ring was used for packing purposes. It simply would not keep the steam from blowing through, so as a last resort the chief engineer tried the experiment of using a solid cast iron piston and cutting four water grooves in the rim for water packing, the cylinder condensation providing the water. This kind of a piston keeps almost absolutely tight for a period of two years. At the end of that time the old piston is thrown in the scrap heap and a new piston of the same kind is fitted. The cost of the new piston is only $18 (3/15/0) and you can bet that it pays for itself in a short time right at the coal pile. For larger cylinders there does not seem to be anything much better than the old-style packing rings set out by little springs. The trouble with these is that the rings will wear down and the springs will lose their elasticity. It therefore pays at intervals to peen out the rings and to have the springs reset and retempered. If you do not believe there is economy in keeping pistons tight, just test some of your own; if they blow through, stop the leakage as much as you can and then watch your coal pile.

When you ride around in the subway these days some one is always shouting "Watch your step!" When you get aboard your ship some one ought to shout "Watch your pistons!"

Yours for economy,

Old Scotch

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Effect of Slipping of Eccentric

Q.—Why does an engine speed up when the eccentric slips?
E. E.

A.—If an eccentric slips when an engine is running, it decreases the angular advance. Decreasing the angular advance delays the valve events, and until the slipping is large the predominating effect is that of delayed cut-off with consequent increased revolutions.

Calorific Values of Coal and Oil

Q.—What are fair calorific values of American coal and oil?
P. A.

A.—Values customarily taken for general comparisons are 14,000 B. T. U. per pound for coal and 19,000 B. T. U. per pound for oil, but individual grades of each vary largely. Coal from different parts of the United States varies from 10,200 to 15,950 (tests of United States Geological Survey, 1904-1906). American oils run about as follows (from *Marine Steam*, published by the Babcock & Wilcox Company, New York):

Mexican	17,500
Californian	18,700
Texan	19,000

Size, Speed and Fuel Consumption of 600-Horsepower Diesel Engine

Q.—Can you give me approximate overall dimensions and weight of a Diesel engine to produce 600 brake horsepower? Also at what revolutions per minute would it run and what should be expected for its fuel consumption?
H. D. S.

A.—A two-cycle marine Diesel engine put out by the Maschinenfabrik Augsburg-Nurnberg (M. A. N.) Company, and listed as one of their "light" type has the following dimensions:

Length overall	15 feet 9 inches
Width overall	3 feet 11½ inches
Height necessary for dismantling	6 feet 11 inches
Depth necessary below shaft	1 foot 8 inches
Revolutions per minute	450
Brake horsepower	600
Fuel consumption, approximately,	0.5 pound per brake horsepower
Total amount, approximately,	21,000 pounds per horsepower

This type of engine is used largely for submarines, gunboats, etc. A similar engine of their "heavy" type, as used in tugs, etc., weighs about 120 pounds per brake horsepower, as against 35 pounds per brake horsepower for the engine described above. The heavy type has a slightly better fuel consumption.

Book on Diesel Engines

Q.—Can you give me the name of a good book on Diesel engines?
STUDENT.

A.—"Diesel Engines for Land and Marine Work," by A. P. Chalkley, published by A. P. Constable & Co., London, and in this country by D. Van Nostrand, 25 Park Place, New York.

The Otto Cycle

Q.—What is the Otto cycle? Is it any different from the ordinary four-stroke cycle of a Diesel engine?
MOTOR.

A.—The Otto cycle is the four-stroke cycle (1) admission of charge, (2) compression, (3) explosion and expansion, (4) exhaust of burned charge. The Diesel cycle, however, differs slightly from it in that the early part of the third stroke is the injection and combustion of the fuel, and the rest of this stroke is the normal expansion of the oxidized charge. The expansion or third stroke line of the two cycle engine might be compared to the expansion lines of two indicator diagrams from steam engines; one with an extremely short cut-off corresponding to the Otto cycle, and the other with a longer cut-off corresponding to the Diesel engine cycle.

Temperature of Stack Gases

Q.—(1) With six single-ended Scotch marine boilers, 190 pounds steam pressure, oil for fuel, would you consider 600 degrees F. temperature of stack gases good practice? (2) Would it be more economical to bring temperature of stack gases down, say to 400 degrees F. or 500 degrees F., by retarding in the tubes more? (3) Would there be any danger of dropping a furnace crown in consequence? (4) What would be the safe, lowest temperature of stack gases you would recommend, not to take draft into consideration, or assuming that the draft is good?"
K. T.

A.—(1) Yes, 600 degrees F. is very good stack temperature for natural draft.

(2) Provided the chemical composition of the flue gases is not changed disadvantageously, any reduction in stack temperature which may be made is a gain, as less heat is thrown into the air. It might be possible to bring the stack temperature to 500 degrees, but I think it doubtful if a temperature as low as 400 degrees could be obtained in this installation without attendant undesirable features.

(3) Probably not, but this question cannot be definitely answered without a study of the drawings of the boiler and uptake.

(4) 450 to 500 degrees F. There is a theoretical discussion based upon the difference in density between the heated air and the cold air which leads to the general conclusion that the best natural draft occurs in chimneys when the *absolute* temperature of the hot gases is $\frac{25}{12}$ of the surrounding atmosphere. This takes no account of the increase of draft due to the aspirating effect of the chimney top and other important effects, but is interesting and gives us some information. To take a specific case,

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if the air were at 60 degrees F. the absolute temperature corresponding would be equal to 60 degrees + 460 degrees = 520 degrees absolute.

$$520 \times \frac{25}{12} = 1{,}085 \text{ degrees absolute} = 625 \text{ degrees F.}$$

Experience from actual trials seems to indicate that for natural draft, stack temperatures of from 600 degrees to 700 degrees F. are acceptable and temperatures 450 degrees to 550 degrees F. for forced draft and small tube conditions. Higher temperatures are frequently found when the grates are forced to high rates of combustion or large capacity oil burners are used.

Equivalent Evaporation

Q.—Will you please explain what is meant by "equivalent evaporation"? B. M.

A.—If there are two exactly similar boilers, one operating at 250 pounds pressure and the other at 70 pounds pressure and burning the same fuel, the boiler with 250 pounds pressure will evaporate less water per pound of coal than the 70-pound boiler, simply because more heat is required to vaporize a pound of water at 250 pounds pressure than at 70 pounds. Obviously, it would be unfair to quote boiler performances in terms of evaporation which did not take account of the pressure and quality of the steam delivered. This led to the custom of reducing all test evaporations to a common standard known as "equivalent evaporation from and at 212 degrees," which is the amount of water which would be evaporated at atmospheric pressure from feed water at 212 degrees by the B. T. U. used to evaporate one pound under the actual conditions.

For example, the boiler operating at 70 pounds pressure generates steam with a total heat of $r + q^* = 286.2 + 896.8 = 1{,}183$ B. T. U. If we consider the feed temperature was 100 degrees F., then the feed water had a heat contents of $q = 68$, so that the net B. T. U. put into each pound of water to vaporize it into steam was $1{,}183 - 68 = 1{,}115$ B. T. U. In a similar way for steam to be formed at atmospheric pressure from feed water at 212 degrees requires 969.7 B. T. U. (r = 212 degrees), therefore

$$\frac{1{,}115.0}{969.7} = 1.150$$

is the factor by which the actual evaporation of the boiler at 70 pounds pressure should be multiplied to reduce it to the "equivalent evaporation from and at 212 degrees." For the 250 pounds boiler using feed at the same temperature (100 degrees) this factor is 1.169. (For table of these factors for a wide range of pressures and feed temperatures, see Kent's Handbook, page 875 *et seq.*)

Air Vessel on Pump Suction Line—Number of Coils in Safety Valve Spring

Q.—What are the advantages of having an air vessel on the suction pipe line of a pump the same as on the delivery? And what would be the best position in which to place such an air vessel? We have a pump which does "general service" and has already broken its suction pipe away from one of the flanges, owing, probably, to the excessive jarring and vibration which take place when we are pumping on the ash ejector.

Please give a simple illustration showing how to determine the number of effective coils in a safety valve spring.

A.—In pumps which have long suction lines it is quite as essential to fit an air vessel on the suction line as on the delivery, but great care should be taken to properly locate it. It should be placed near the pump and so that it forms a continuation of the straight length of suction line. The action of the pump causes rapid changes in the velocity and there is apt to result a serious water hammer unless this precaution is taken. Your reason for the breaking of the suction pipe at the flanges is probably correct.

There are several forms of spring formulæ, depending upon what items are considered as known. For the instance given there would probably be known the dimensions of the spring wire, load and material, and for that case the following formula would probably be used as the movement of the loaded point is usually one of the major elements of the design. The formulæ for this case follow:

$$\delta = \frac{12\, R^2 X\, L}{b\, h\, (b^2 + h^2)\, C} \quad \text{for springs made of wire of rectangular cross section}$$

and

$$\delta = \frac{32\, R^2 X\, L}{\pi\, d^4\, C} \quad \text{for springs made of wire of circular cross section}$$

The letters have the following significance:

δ = displacement of point (in inches) when load is applied,
L = load in pounds,
R = radius of spring,
X = total length of wire forming spring (not length of spring),
b and h = sides of rectangular spring wire in inches,
d = diameter of round spring wire in inches,
C = shearing modolus of elasticity.

Example—Suppose we wish to know how many turns of ¾-inch diameter round steel wire will be necessary, if rolled into a spring of 2-inch diameter to support a load of 10,000 pounds on a deflection of 2 inches. For steel of this sort, $C = 12{,}600{,}000$; therefore

$$\delta = \frac{32\, R^2 X\, L}{\pi\, d^4\, C},$$

so

$$2 = \frac{32 \times 1 \times X \times 10{,}000}{\pi \times \frac{71}{256} \times 12{,}600{,}000}$$

and

$$X = 68.6 \text{ inches.}$$

Each coil is 2π inches long, so the number of coils is

$$\frac{68.6}{2\pi} = 10.9.$$

CORRECTION.—In the answer to the question regarding the stresses in expansion bends of steam lines, published on page 314 of our July issue, it is stated that the straight pipe will increase in length $48 \times 12 \times .0000065 \times 310 = 1.61$ inches. There is a typographical inversion of figures in the result given. Instead of 1.61, it should be 1.16, which is the figure used a few lines below in the answer.

SHIPBUILDING IN CANADA.—The Department of Marine and Fisheries of Canada, in its report on shipbuilding in Canada during 1914, gives a total new tonnage of 43,346, the largest figure in fourteen years. Over half of this tonnage was built in the province of Ontario.

MEMBERS OF INVENTIONS BOARD.—The names of four members of the proposed advisory board on naval inventions for the United States Navy have been announced. Those selected by the American Society of Mechanical Engineers are Spencer Miller, of New York, and W. L. R. Emmet, of Schenectady, N. Y. The Society of Automobile Engineers has chosen Howard E. Coffin and Andrew L. Riker, past presidents of the society.

* r = heat of vaporization
q = heat of liquid
Steam Properties from Peabody's Tables at Pres. = 70 + 14.7 = 84.7.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Design of Spare Propellers

A British steamship was towed into Bermuda a few weeks ago with her tail shaft broken and the propeller gone. The vessel was towed a distance of about 1,100 miles, which meant not only a loss of time to both towing and towed vessels, but a heavy bill for towage to be taken care of by the underwriters. The accident happened in moderate weather, and conditions were favorable for "tripping" the vessel at sea and for withdrawing the broken shaft and replacing it with a spare shaft and propeller, but as assistance was offered a few hours after the breakdown it was considered advisable to accept it.

The spare propeller which was carried on deck was a regulation four-bladed solid cast iron one, 18 feet in diameter and of considerable weight. It would have been necessary to have removed the propeller from its location directly aft of the mainmast to a point further aft, a distance of probably 65 feet, and then to have lowered it over side in a convenient location for fitting it on to the tail shaft. The ordinary derrick and gear of tramp steamers is usually not sufficiently strong to handle safely such a large weight, and, aside from the probable loss of the propeller, should the gear give way a serious accident to the crew, and possibly death, might accompany such an accident.

For convenience of handling, easily and safely, under the ever-present difficulties in performing work of this nature at sea, why not adopt a sectional, two-bladed propeller for the spare? This would consist of a boss and two blades, each piece easily handled without special rigging and for all practical purposes just as efficient as the ordinary four-bladed wheel. The diameter and pitch would be similar to that of the four-bladed wheel, and probably 75 percent of the surface could be provided for in the two blades. While this may cause a slightly increased "vibration," yet it would only be for a comparatively short time, as vessels are invariably dry docked at the first convenient port.

W. Blackburn Smith,
Official Marine Surveyor, Bermuda.

Fire-Room Emergency Escape

The sinking of the *Titanic,* with her frightful toll of life, caused nations and peoples to pause and consider what steps could be taken to insure greater safety for those "who go down to the sea in ships." This awakening took the form of national and international safety-at-sea congresses, resolutions by civic bodies, boards of trade and chambers of commerce. It gave rise to articles in the daily press, in shipping and trade journals, to discussions in engineering and technical societies, and to the publication of books describing the "unsinkable *Titanic.*"

The greatest good, by far, resulted from the deliberations of official congresses, and from such of their recommendations as have been given the force of law or executive order by the various maritime nations. These recommendations dealt chiefly with stability, watertight integrity, capacity and availability of lifeboats and their proper handling, and were intended to protect the passengers from the fury of the waves.

Scarcely a recommendation, suggestion or admiralty order took into account the safety of those hard-working members of the crew who are imprisoned below in the firerooms and engine rooms, and who, being out of sight are out of mind, but without whom the five-day passage of the Atlantic is impossible. It seems to have been forgotten that these men with their officers are daily and hourly exposed to the danger of escaping steam from a ruptured pipe or damaged boiler. Neither did the discussions or safety orders take into account the fact that as safety for passengers is secured by greater subdivision and unpierced bulkheads the chances of firemen avoiding injury from escaping steam is correspondingly reduced.

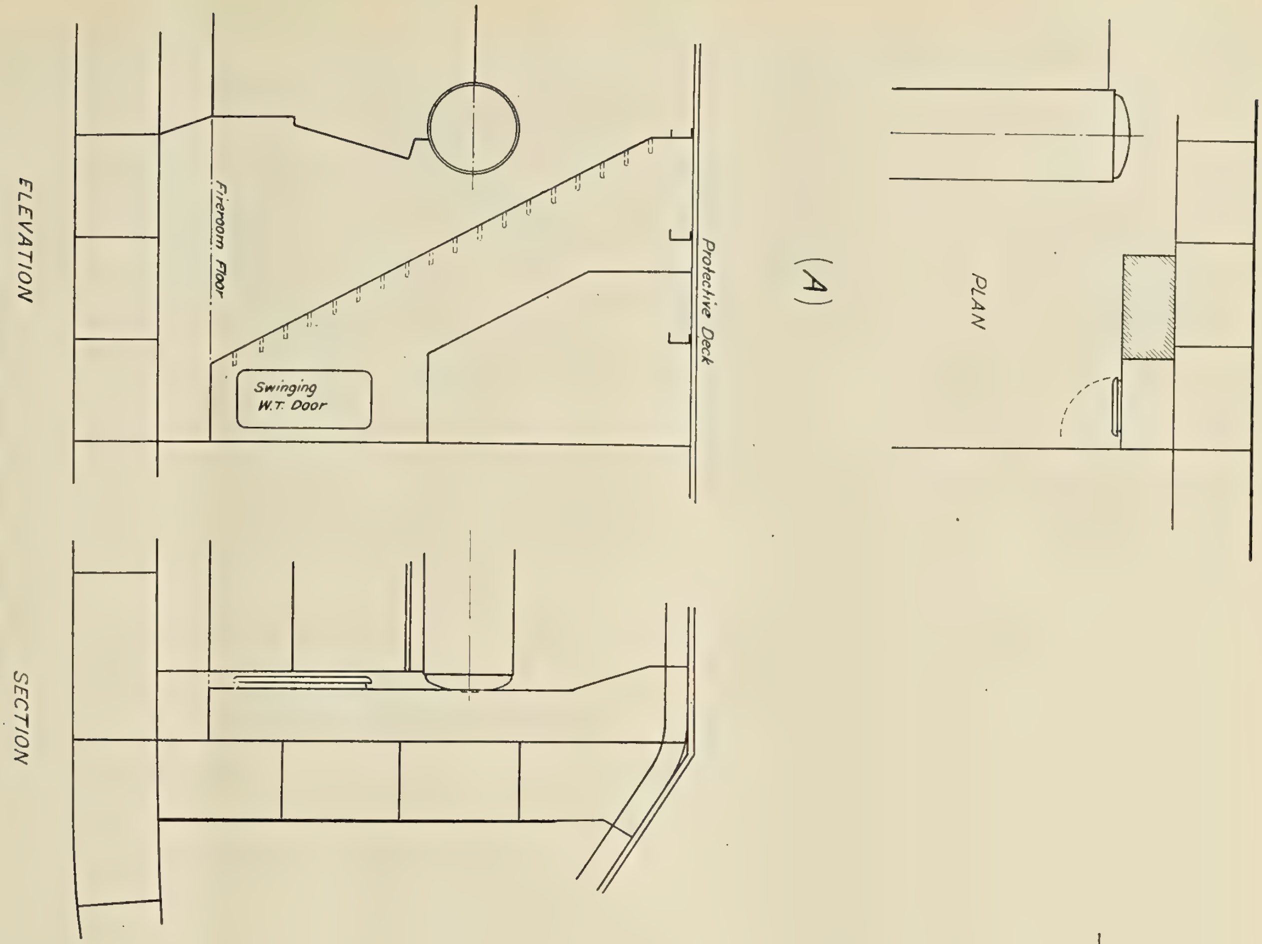
In the United States navy only, so far as is known to the writer, were any steps taken to provide firemen with better chances for escape in case of boiler damage or steampipe rupture. On the *New York* and *Texas,* the two latest dreadnoughts commissioned, the naval constructor provided inclined vertical trunks leading direct from the fireroom floor plates to the gun deck level. There is one of these trunks on each side of each fireroom, each communicating with the fireroom by means of a full-size ship standard door above the floor plate level. This trunk and its door is shown in "A" in the illustration.

These trunks were considered necessary on ships that have communicating doors through bulkheads separating adjacent machinery compartments. Naturally these doors afford means for men to escape from one compartment to another without the necessity of climbing up in the path of the steam flow. How much more necessary will be real emergency escapes in the case of vessels where the bulkheads are unpierced, or are only pierced for standard manholes!

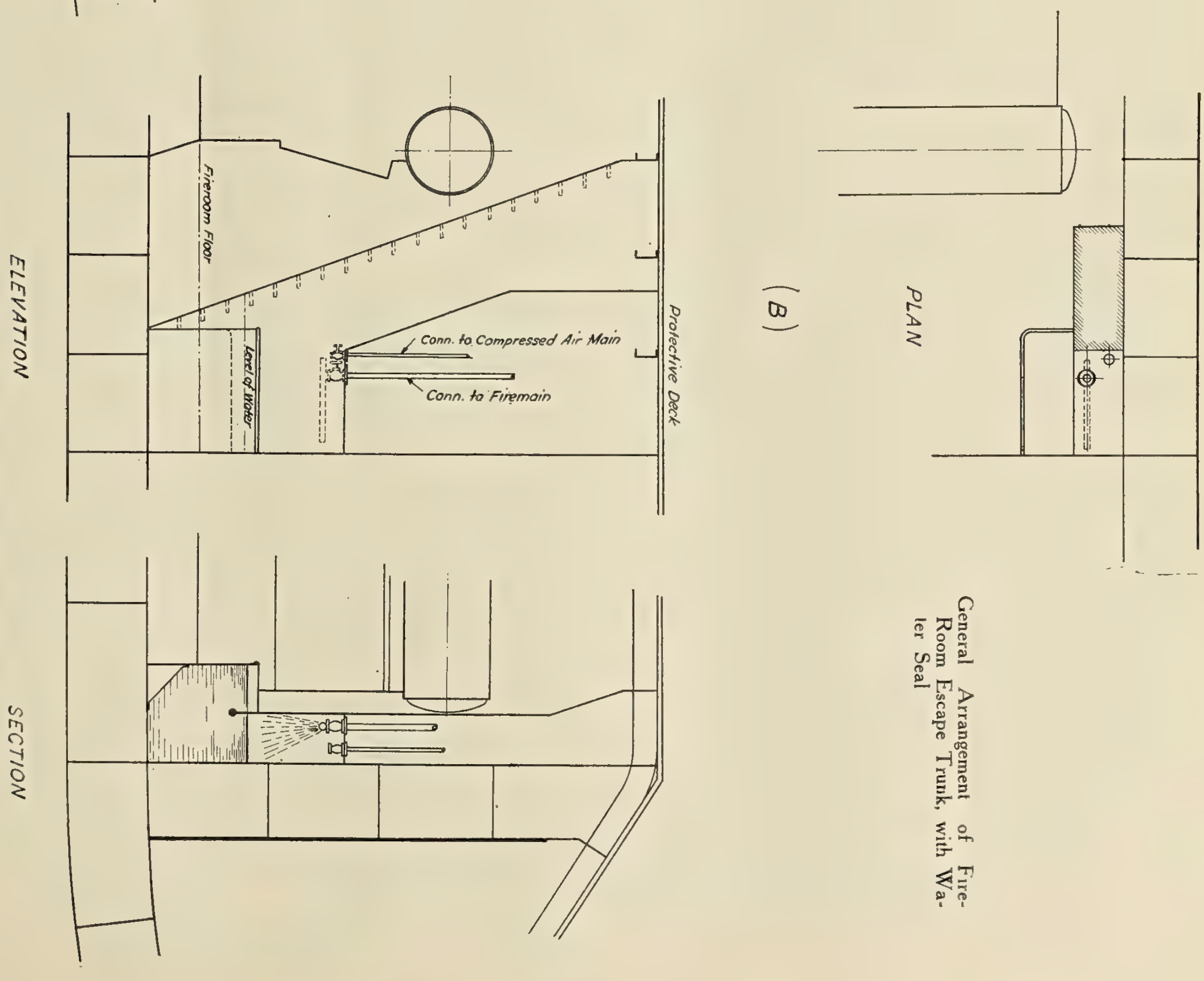
This construction, if not already an accomplished fact, is likely to be brought about as a result of such investigations as followed the *Titanic* disaster, and from the experiences of the great war now waging in Europe. If proof be needed to show the necessity for emergency escapes and to emphasize the inadequacy of the inclined trunk as now fitted in certain men-of-war, the accident on the U. S. S. *Salem* at Progresso, Mexico, last fall furnishes it.

The *Salem,* a scout cruiser, is equipped with Fore River boilers and engined with Curtis turbines. Her boilers are arranged four in each of three watertight firerooms. There is no communicating door between firerooms. The bunkers are outboard of and adjacent to the firerooms, one bunker abreast each boiler, approximately. The bulkhead between the fireroom and bunkers is pierced for a standard watertight door. There is no means of escape from the fireroom except through the roof of the fireroom or into adjacent bunkers, or possibly into double bottoms under the fireroom bilge, if there should be time.

While backing at full speed coming to anchor at Progresso, Mexico, the steam and water was hauled out of No. 1 boiler so rapidly that the inexperienced crew permitted, or rather failed, to prevent low water, which resulted in pulling some four or five tubes out of the tube sheet of the steam drum. The inswinging furnace doors held, but the ashpan doors gave way, so that fire, ashes and steam blew out near the floor plate level, filling fire-



Fire-Room Escape Trunk as Now Fitted



Fire-Room Escape Trunk, Peabody Type

General Arrangement of Fire-Room Escape Trunk, with Water Seal

room with steam and noxious gases. Some of the men in attempting to escape up through the fireroom sprung the cover of the escape hatch in the roof of the fireroom, relieving the air pressure in the fireroom, thereby increasing the escape of steam into the fireroom.

Before the men who were in the open fireroom could get over the port side and pass into coal bunkers on the uninjured side of the vessel, two men were fatally burned. One coal passer was in the bunker abreast No. 1 boiler, the bunker door being open. Notwithstanding the fact that the bunker was otherwise closed, so that no chimney effect was produced, still the steam rushed into this open bunker space in such volume and with such velocity that the man was scalded to death in the forward end of the bunker where he was shoveling coal.

The fact that steam flowed promptly into the empty space of this bunker through a door of the same size and located at the same level as the door to the escape trunks on the *New York* and *Texas* shows conclusively that with the draft induced by the chimney effect of the vertical inclined trunk it would invite disaster in a real emergency. Men would enter it in the frantic endeavor to escape, but the steam, at a considerable velocity, would scald men well up the ladder so that they would tumble on those below and a veritable death trap would result.

The two men who were in the open fireroom undoubtedly could have escaped fatal burns if they might have dropped into a tank of water on their own side of the fireroom and moved through the water (an effectual steam seal) to the far and safe side of the bulkhead separating the fireroom from the escape trunk.

An emergency escape for permitting men in a compartment to reach a point of safety, while at the same time preventing steam or other gases from following, has been developed largely through the efforts of Mr. Ernest H. Peabody, chief engineer of the Babcock & Wilcox Company. This device, as applied to the present escapes on the battleships *New York* and *Texas,* will be readily understood from the illustrations.

In view of Secretary Daniels' well-known interest in the welfare of the enlisted men, and of his recent determination to create an Advisory Board of Invention under the Navy Department, International Marine Engineering presents this invention on its merits, believing it will offer greater safety to the crews of both naval and other vessels than has heretofore been provided, feeling assured that the Navy Department will lead in the "Safety First" crusade.

Explosives of the Engineer's Department

Would you be willing to sit on a high explosive shell or on a submarine mine and peacefully smoke your pipe, or would you allow one of your men to do it? I think you would hardly do either, yet, dangerous as this seems, there would not be very much danger to the smoker, because in both cases the explosive is well protected and must be detonated by special means. A little flame or a few sparks around it would be quite harmless.

But while the very suggestion of the use of a high explosive shell for a smoking seat seems preposterous and sounds like an attempt to commit suicide, many of you are doing and allowing others to do much more dangerous things around your steam pipes and boilers. By this I mean that you are working around live steam, under high-pressure, under conditions that would make a packer of high explosives quit the job, because he would find it too dangerous for him.

The presence of steam, at pressures from 125 to 265 pounds, in steam lines and boilers, in many places separated from the operator by only a thin gasket held between two flanged and bolted surfaces, ought to contain a sufficient element of danger to satisfy even the most foolhardy. That it does not is conclusively shown by the overpowering desire that so many men (and even some engineers) seem to have to work at every joint that shows signs of leakage or failure. If this desire to work were expressed when the steam was turned off the line, it would be quite commendable, but, working as they do with full pressure on shows that the operators are either foolhardy or ignorant of the great danger to which they are subjected.

The most usual place for leakage to occur on board ship is at a flanged joint. In practically all such cases the flanges are secured together by ordinary commercial bolts. Any person can easily understand that flange bolts must be under a considerable stress when well set up, especially when pressure is on the line. The metal of these bolts may be of poor quality; very few of us are in a position to know just how good the metal of any particular lot of bolts was when installed. Many bolts may have been cracked and have rusted badly in these cracks. Some may have the threads practically stripped, while in others the whole bolt may be badly rusted. In nine cases out of ten the workman does not know the condition of the bolt when he puts his wrench on it.

If the bolt carries away or the threads strip, what is going to happen? Usually not very much, I am glad to say; but there are grave possibilities, as has been repeatedly demonstrated by many serious burns and scalds received by men at this work. If there are more than three bolts in the flange, the only damage will probably be a piece of the gasket blown out at the point where the broken bolt occurs, but if there are three or less, the flange may open quite badly, releasing a jet of steam and scalding water. Since the operator will probably be on the side on which he is making repairs, he stands a very good chance of getting badly burned, especially about the hands and face.

The possibilities (and probabilities) of accident are not limited to the case of a flanged joint as just described; instead of this, they extend to all parts of steam machinery. The danger from small galvanized iron pipes with screwed unions and couplings is very real. It is not an uncommon thing for such a pipe to break completely off in the threads when a particularly strenuous effort is made to set up on it.

Of course the greatest of all such dangers lies in the attempts frequently made to set up on a manhole plate when the boiler is steaming. Except in case of emergency this is absolutely inexcusable, as the accidental breaking of a dog, nut or stud may cause the death of everyone in the fireroom. In every such case the pressure should be taken off the boiler before attempting repairs.

The writer realizes that it is necessary to carefully follow up newly made joints as the pressure comes on them, but not after the pressure is fully on. It is only when working with such a joint as that made on a cylinder head, where there are a great many holding bolts, that setting up can be done with impunity.

Some object to allowing the pressure to be removed from a boiler before working on it on the plea that it takes too much time and is too expensive. It cannot be denied that it does take time, is expensive, and may be the cause of great inconvenience, but nevertheless it is worth while in the end.

The writer has found that, when working with boilers, it pays to warm up the boiler and follow up the newly made joints as soon as the job is finished, rather than to

wait until the boiler is needed and then find several gaskets leaking. Warming up is done in a Scotch boiler by using the hydrokineters and circulating the water with a spare feed pump. The temperature will soon reach the boiling point and some steam pressure can be obtained in this manner. If the gaskets are all well followed up and all prove to be tight, there is very little chance that they will give trouble when fires are lighted for service. It is surprising to see what a little difference in the coal consumption will be made by carrying out this process on one boiler. The difference is hardly noticeable.

The same process is carried out in a watertube boiler by using a very light fire. The whole operation can be done in two or three hours, and if it is necessary that the boiler shall be ready for service without fail at a set time, it will be found to pay in the long run.

The writer would not say that steam joints should never be set up while under steam, but he desires to say that it should only be done in case of some reasonable necessity, and even then in a very circumspect manner and with the greatest of caution. W. W. B.

Some of the Most Common Troubles with the Marine Gas Engine and Suggestions for Determining and Remedying the Same

While it is almost impossible for one to enumerate all of the conditions which will interfere with the efficiency of a marine gasoline (petrol) engine, it is the writer's purpose in this discussion to consider the most common causes of trouble and give practical suggestions for determining and remedying same. To the expert much of the matter presented may seem superfluous and elementary, yet it is believed that it will be of interest and benefit to the average reader who is interested in the gas engine for marine propulsion.

The first point to be considered is the amount of compression obtainable in the engine cylinder, for upon this depends the successful and economical operation of the engine. Different fuels require different compression pressures, the average compression of an engine using gasoline (petrol) being between 65 and 70 pounds per square inch, while for an engine using kerosene (paraffin) should be in the neighborhood of 50 pounds. The amount of compression may be determined by inserting a pressure gage in the spark plug or priming cup opening and turning the engine over briskly by hand.

In cases where the compression is found to be too little and it is positively known that no compression leaks exist, the following methods are available for increasing same:

(a) Adding liners between the connecting rod brasses.

(b) Fitting a longer connecting rod.

(c) Lowering the position of the piston pin in the piston.

(d) Fastening plates to the top of the piston or under side of the cylinder head.

(e) Decreasing the gasket between the cylinder and cylinder head, or between the upper crank case and bed plate.

It is upon the fit of the piston and rings, more especially the latter, that compression mainly depends. The piston should fit the cylinder bore with but little looseness, the general practice being to allow about .005 inch clearance at the top and about .003 inch at the bottom. The piston rings should possess sufficient elasticity or springiness to press uniformly against the cylinder walls, and should be so located in the piston that no two joints come in line with each other. The rings should slide freely in their grooves, but should have no perceptible side movement.

The importance of having the compression exactly right should not be overlooked, and it is therefore essential that the engine be tested frequently for leaks. This test may be made by turning the engine over against compression and holding it at that point where compression is at its maximum. Should there be any leakage, the effort necessary to hold the engine in this position will gradually decrease. For multiple cylinder engines this procedure should be followed on each individual cylinder, the compression being relieved on all cylinders except the one under test.

While the engine is running, compression leakage at any accessible part, such as the cylinder head joint, spark plug, etc., may be determined by squirting a little lubricating oil around the place where the examination for leakage is to be made, and if a leak exists bubbles will appear in the oil.

A dark discoloration along the outer circumference of both piston and rings is a positive sign that the hot gases of combustion have been leaking by them and steps should be taken immediately to locate and remedy the trouble.

Often it will be found that the rings are stuck, due to a gummy deposit in the grooves caused by excessive lubrication or a poor grade of lubricating oil. If such is found to be the case, they should be first loosened by soaking in kerosene (paraffin), carefully removed and the grooves thoroughly cleaned of all deposit. To remove a piston ring, three pieces of tin or sheet brass about 3/8 or 1/2 inch wide by 6 inches long should be provided. By slipping one piece under each end of the ring and one under the middle, the ring can easily be removed.

Examine the rings to see whether they possess sufficient elasticity to function properly. A weak ring may sometimes be improved by lightly peening it on its inner surface, the outer surface resting on a hard, smooth foundation. This operation, which tends to expand the ring and cause it to press harder against the cylinder walls, must be carefully performed, due to the fact that the rings are generally made of cast iron, which is very easily broken. If the piston rings work around in their grooves so that their joints come in line, compression leakage is very liable to result. To avoid this trouble, fasten the rings in their proper location by means of small pins, taking care that these pins are securely held in the piston and are of ample size, so as not to shear off.

Shiny spots at the joint and diametrically opposite indicate that the ring does not fit the cylinder bore properly. In manufacturing piston rings they are made slightly larger than the cylinder bore and then split in order that they may enter the cylinder. After being split the ring should be pressed together and the outer surface turned or ground to a true circle, otherwise they will assume an elliptical form when placed in the cylinder and not fit the bore properly. Perfect fitting rings should show bright all around the outer circumference.

A piston that is worn will permit the charge to leak past and thereby cause a loss of power. When worn to a considerable degree, the piston will make a slapping noise against the cylinder bore. In this case the only remedy is to fit a new piston. In replacing a piston in a cylinder having its head cast integral, care must be taken not to slide it in too far, as there is danger of the top ring sliding past the counter-bore, or the enlarged diameter of the combustion chamber. If this happens, the ring will instantly expand over the edge and prevent the piston from being returned to its proper position.

Should compression leakage be traced to the piston, the

trouble, if caused by the rings being stuck, can often be overcome by pouring about half a cup of kerosene (paraffin) into the cylinder through the spark plug opening or priming cup and allowing it to stand for several hours. The kerosene (paraffin) cuts and dissolves the gummy deposits and allows the rings to move freely. After the rings have been freed in this manner, rinse out the cylinder with more kerosene (paraffin) and well lubricate it before again starting the engine.

A cylinder that is scored or scratched, or one that is worn out of round, is often the cause of lost power and overheating. A scored cylinder may be the result of overheating, broken piston rings or a loose piston pin. In cases where the scoring is only slight, a small quantity of graphite mixed with the lubricating oil and fed to the cylinder will fill in the scratches and make the cylinder bore perfectly smooth. If this procedure should not prove satisfactory, regrind the cylinder and fit new rings in the piston. When the cylinder is found to be worn out of round or to be deeply scored, the only remedy is to rebore it and fit a new piston of larger diameter.

Compression leakage can often be traced to the joint between the cylinder and cylinder head, and if this trouble cannot be remedied by tightening up the studs that hold the head in place a new gasket must be provided. This gasket should be about 1/32 inch thick and of a material that will withstand a high degree of heat as well as pressure.

In removing a cylinder head for the purpose of fitting a new gasket, do not hammer it or insert a chisel between it and the cylinder. After removing all the connections and the nuts that fasten the head in place, turn the engine over against compression and the pressure will loosen the head and make its removal easy. Carefully scrape the bearing surfaces of both cylinder and head of all traces of the old gasket. Cut the new gasket, taking care that it does not project into the cylinder and that there is sufficient clearance around the stud holes to prevent it from buckling and thereby preventing the head from seating evenly. Coat the surface of the gasket that comes in contact with the cylinder head with a mixture of tallow and flake graphite. This will prevent the gasket from sticking to the head and permit of its removal without destroying the gasket. When the head is in place, first tighten up all the nuts with the fingers; then, using a wrench, tighten up each nut a trifle at a time, going around the cylinder three or four times and exerting the same pull for each nut until they are all as tight as it is possible to get them. Never apply full pressure to one nut before the others have been tightened, as such a procedure will tilt the head and make a perfect seating impossible. After the engine has started and thoroughly warmed up, go over the nuts again and tighten them up still further.

In the case of the two-cycle engine, loss of power can often be attributed to a leaky crank case, due to defective gaskets or worn crankshaft bearings. Remedy this trouble without delay, for it must be borne in mind that no two-cycle engine can operate efficiently unless the crank case is absolutely tight. The amount of crank case compression should be in the neighborhood of six pounds per square inch.

The valves and their operating mechanism are a prolific cause of compression leakage, and particular attention should therefore be paid to these parts. For efficient operation the valves and valve seats should be perfectly smooth and free from grooves or pitting. Often a particle of carbon or grit will lodge between the valve and its seat and prevent the valve from seating properly. This can usually be dislodged by rotating the valve on its seat. The intense heat in the cylinder and the action of the gases on the valves not only causes them to warp, but also causes the seating surfaces to become rough and pitted, thereby causing compression leakage and loss of power. The most trouble in this respect is due to the exhaust valves, which are surrounded by hot gases during the exhaust stroke.

Leaky inlet valves are usually indicated by back-firing or explosions in the carburetor and intake manifold, due to the flame leaking through the valve and igniting the fresh mixture in the intake. Leaky exhaust valves will cause misfiring or loud explosions at the exhaust outlet, due to part of the combustible mixture escaping through the valve into the exhaust pipe and being ignited by the succeeding exhaust of the engine.

Valves which are found to be worn or pitted should be ground without delay, otherwise the trouble will soon increase to such an extent that the only remedy will be the fitting of new valves. To regrind a valve, first lift it from its seat and apply a mixture of lubricating oil and fine emery, or any good valve-grinding compound, to the seating surfaces. Now replace the valve and, applying just enough pressure to insure contact between the two seating surfaces, rotate the valve back and forth, lifting it from its seat occasionally to prevent grooving and to redistribute the abrasive. When both valve and seat present a smooth, even surface the grinding is complete, but for accuracy the following test should be made: Spread a little Prussian blue over the valve seat, return the valve and, applying a slight pressure, give it a fraction of a turn. If the surfaces have been perfectly ground the blue will show uniformly spread over the seat, otherwise bare places denoting high spots will be seen. When grinding valves in place on an engine, take care to prevent any of the grinding compound from gaining access to the cylinder bore by stuffing up all openings with waste. After grinding, wash the valves, valve stems and guides with kerosene (paraffin) in order to remove all traces of the grinding compound, which, if permitted to remain, would cause wear and cutting.

Weak or broken valve springs will prevent the valves from seating properly. Weak springs, which have lost their temper due to excessive heat, may be detected when the engine is running by inserting the end of a screw driver in the spring and pressing it against the collar on the valve stem. This increases the tension of the spring, and if the engine now operates better it is a sign that the spring is too weak to function properly and should therefore be replaced.

When the valves are closed there should be a clearance between the valve stems and their operating mechanisms, for if these parts were continually in contact the valves would not be able to seat properly and leakage would be the result. The amount of clearance depends on the size of the engine and varies from the thickness of a visiting card for small engines to about ⅛ inch for large engines. Wear on the valve seats and regrinding decrease the clearance, and care must therefore be taken to keep it the same as it was when the engine was new.

Excessive cooling of the cylinder walls is another cause of lost power, due to the fact that a great amount of heat which otherwise would be transformed into mechanical energy is absorbed by the cool walls. Regulate the volume of water delivered to the jackets so that the temperature of the discharge will be in the neighborhood of 140 degrees F. Insufficient cooling will cause rapid wear of the cylinder and piston rings, due to the excessive heat destroying the lubricating oil.

Faulty carburetion will greatly reduce the power and efficiency of the best engine built. It is essential that the mixture be exactly correct, neither too rich nor too lean,

for in either case loss of power and irregular operation will be the result. A mixture that is too rich is indicated by the engine gradually slowing down or misfiring badly with black smoke issuing from the exhaust outlet, while a lean mixture is indicated by the engine back-firing and coming to a sudden stop.

If the above trouble is noted when the engine is running at low speed, see that the air valve is seating lightly but firmly and regulate the amount of fuel by means of the needle valve. If the trouble is noted at high speed and the carburetor has been properly adjusted for low speed, increase or decrease the tension on the air valve spring as the occasion may require—i. e., if the mixture is too rich, decrease the tension, and if too lean, increase the tension. If this does not remedy matters, it will be necessary to regulate the fuel by means of a slight adjustment to the needle valve. Endeavor to make all adjustments for high speed by means of the air valve, for any change in the needle valve will interfere with the low speed adjustment.

There are numerous types of carburetors on the market, but for marine purposes the float feed type is generally used. With this type of carburetor the most probable cause of imperfect carburetion is the failure to maintain the proper level of fuel in the float chamber and consequently at the spray nozzle. If the level is too high, the mixture will be too rich, and if too low, the mixture will be too lean. This trouble may be caused by particles of dirt lodging between the float controlled valve and its seat, thereby preventing the valve from seating properly and allowing too much fuel to enter the float chamber, or it may so constrict the opening as to prevent sufficient fuel from entering. Often it will be found that the float has become heavier by absorbing the liquid fuel, in which case too much fuel will be admitted to the float chamber. If a particle of dirt lodges in the spray nozzle it will prevent the passage of sufficient fuel to insure proper mixture. Air leaks between the carburetor and the engine are to be avoided, as the air will dilute the mixture and cause loss of power.

The ignition system is more susceptible of derangement than any other part of the engine, and is perhaps the greatest source of trouble to the average motor boat owner. Troubles are indicated by the same symptoms as are troubles with the carburetion system, and for this reason it is sometimes very difficult to determine which system is at fault.

When the engine has been operating irregularly or misfiring, look first to the source of energy, if a battery system is employed. Go over the wiring and see that there are no broken leads or loose connections. Examine the timer for defects and make sure that no short-circuits exist. If, in addition to misfiring, the engine occasionally back-fires and it is known that the trouble is not due to faulty carburetion, examine the timer and vibrator adjustment or the magneto contact points. Misfiring will also be caused by spark plugs having broken insulation or too wide spark gaps, the latter cause being particularly noticeable when high tension magnetos are used.

Loss of power will be caused by weak batteries and underspeeded or dirty magnetos, or by running the engine with the spark retarded or advanced too far. If a dry battery is used, test each cell separately and if any are found to be weak or exhausted, replace with new ones. For efficient operation a dry cell should show not less than six amperes. A storage battery that shows loss of capacity should be carefully examined. This may be caused by insufficient or impure electrolyte, sulphated plates, sediment in the bottom of the cells, or short circuits in or between the cells. For testing dry batteries an ammeter is preferable, but for storage batteries a volt-meter must be used.

A spark that is retarded too far will not ignite the mixture until after the piston has completed part of its power stroke; consequently combustion will be slower, due to the decrease in compression, and a great amount of heat that would otherwise be transformed into mechanical energy is lost through the cylinder water jackets. In addition to lost power, a retarded spark will cause overheating and back-firing. A thumping or pounding sound in the cylinder is an indication that the spark is advanced too far.

Dirty spark plugs are the most frequent cause of misfiring, and for this reason they should be frequently examined and cleaned. Plugs with cracked or oil-soaked insulators should be replaced. See that the sparking points are not too widely separated. For batteries the gap should be 1/32 inch, while for high tension magnetos it should be about 1/64 inch.

Improper vibrator adjustment is the cause of much trouble and expense, as it uses up the batteries and wastes fuel. Adjust vibrator by first setting the spring rather stiff and running the engine at full speed until it is thoroughly warmed up. Then slowly and gradually decrease the tension of the spring until the engine begins to misfire, at which time slowly increase the tension until misfiring stops and the correct adjustment will be the result. The vibrator contact points should be kept clean and smooth.

The question of lubrication should be given the utmost consideration, for without efficient lubrication the best of engines work badly and will soon be worn out. The chief aim of all lubrication is to prevent an immediate metallic contact of parts that glide upon each other, and by introducing a film of oil between them, friction is diminished and the heat carried off better.

In regard to the lubrication of the cylinder there are special points to be considered, for it must be remembered that the cylinder walls stand alternately in communication with the piston and the hot gases of combustion. The greatest care, therefore, should be taken in the selection of the cylinder oil, and nothing but mineral oils capable of withstanding the excessive heat should ever be used. Never use machine oil or steam engine cylinder oil, as they are of low fire test and will burn instantly, leaving a deposit in the cylinder.

The lubricating oil must be free from acids and other constituents, such as sulphur, which attack the surfaces and cause damage. If the lubricating oil which drops from the cylinder is of a brown and dirty color, it is a sign that something is amiss. Lubricating oil may be tested for free acid by inserting a piece of litmus paper in the oil. The presence of acid is denoted by the paper turning red. For the lubrication of bearings any good grade of acid free oil can be used.

Excessive lubrication or a poor grade of lubricating oil will result in the formation of carbon deposits in the cylinder and combustion chamber. This carbon is to be found in two forms, one being soft like soot and the other hard like coke. The soft carbon mixes with the gummy residue of the lubricating oil and clogs the piston ring grooves, thereby causing the rings to stick. It also fouls the spark plugs and causes short circuits. Particles of the hard carbon, which usually form at the hottest part of the engine, often become incandescent when the engine is working under a heavy load and, by igniting the incoming charge, cause back-firing. Yellow or blue smoke at the exhaust outlet indicates that too much lubricating oil is being fed to the cylinders.

Norfolk, Va. J. B. Sadler.

Marine Articles in the Engineering Press

Overcoming the Cracking of Pistons in Diesel Engines—Evolution of the Oil Tank Ship—Large British Collier

Cracked and Seized Pistons on Diesel Engines.—This article consists of a full abstract of the remarks of Mr. George E. Windeler, chief engineer of Messrs. Mirrlees, Bickerton & Day, Ltd., given at a meeting of the Diesel Engine Users' Association, at which the subject of cracked and seized pistons was discussed. These remarks are based entirely on investigations carried out by the firm with which Mr. Windeler is associated. In the internal combustion engine, especially of the Diesel type, everything possible is done to keep down the temperature of the cylinder liner, cylinder cover, exhaust valves and exhaust passages which are in contact with the fuel or gases. Special attention has, therefore, to be paid to water cooling arrangements to insure that the circulation is thorough and that no air or steam pocketing is likely to occur. Particular care should also be paid to the arrangements to prevent short circuiting in the water circulation. In the case of the investigations made, it was found that the major portion of the defects that had arisen on cylinder covers and pistons were due to serious deposits having been allowed to form in the water spaces of the cylinder covers and on the cylinder liners. These deposits were not formed while the engine was working, but after it was shut down. To remedy this, engine users are advised where the circulating water is known to be of a considerable hardness, to run water through the water spaces for some time after the engine has been shut down. Where the piston is not water-cooled the heat units which have been absorbed by the piston crown must be transmitted through the body of the piston to the cylinder liner. The piston must, therefore, be designed to accomplish this result, as well as to provide for the transmission of the load applied to the piston crown to the crosshead pin without causing distortion of the piston. The recent practice has, therefore, been adopted of constructing the piston in two portions. The upper portion is secured to the main body of the piston by six or eight square-necked studs, the support to the crown of the piston top being obtained by throwing out a conical cylindrical chamber, which not only gives an equal distribution of stresses from the load on the piston crown, but also forms another lane by which the heat units can reach the body of the piston for transmission to the water spaces. It also permits of uniform expansion. This design has several advantages, one being that different qualities of material may be used for the upper portion of the piston and the lower. Furthermore, should any cracks develop, it is comparatively simple and inexpensive to replace the top. Experiments have proved that cast iron containing high percentages of phosphorus is most unreliable for pistons, and further investigations established the fact that the elimination of phosphorus would, to a large extent, remove the difficulty of cracks developing. It was found that almost invariably the seizures of pistons were due to heating of the piston pin and its bearing, and that these seizures take place almost immediately after starting up. The opinion was formed that when an engine has been set to work and shut down the heat stored in the piston body flows downwards and tends to evaporate the oil in the top end-bearing, with the result that when the engine starts up again this particular bearing is not amply supplied with lubricating oil and seizures take place. By fitting a hand lubricating pump by means of which lubricating oil under pressure can be pumped to all the bearings, including the piston pin bearing, while the engine is being barred around into its starting position before being started up and again by running circulating water through the engine after shutting down this difficulty is minimized. 9 illustrations. 1,600 words. —*Engineering,* July 16.

The Automobile Torpedo.—A brief résumé is given of a most instructive memoir on the automobile torpedo, published in *Le Génie Civil* of June 26. Attention is first directed to the history of the torpedo, and then the article is confined to a description of the Whitehead torpedo. The Whitehead torpedo as now made consists of the following six parts: (1) The striker and detonator, (2) the explosive chamber, (3) the compressed air reservoir, (4) the machinery chamber, (5) the aft flotation chamber, and (6) the tail portion which carries the propellers and rudders. These various devices are fully illustrated and described and the operation of the torpedo is explained. 8 illustrations. 3,400 words.—*The Engineer,* July 23.

Calculation of Top Girder of a Suction Dredge. (Continuation of article published June 9 and reviewed in our August issue.)—On the strength of the main diagram the author shows that a complete moment curve can be constructed for the load of each longitudinal section, eight in all, or four right and four left analagous ones, each with eight ordinates at the center of section and nine ordinates at supporting points. By adding in the form of a table all the corresponding points, a total moment curve is found from which the stress per square inch of section can be found by the relation to the moment of resistance of the longitudinal girder. From this total moment curve the author deducts the supporting loads at each transverse beam either directly or by integration of the shear and moment curves, and, in relation to the moment of resistance of the transverse beams, finds the stress. The results from the example worked out are given in tabular form. 6 illustrations. 2 tables. 2,300 words.—*Schiffbau,* June 23.

Calculation of the Top Girder of a Suction Dredge (Conclusion of above).—It is pointed out that the stresses upon the longitudinal girder and transverse beams are nowhere excessive. This was due partly to the choice of the support of the transverse beams, as a much higher strain would have been experienced in them if they had been rigidly held at the ends instead of being only supported with a corresponding lower strain in the main longitudinal girder. Attention is also directed to the wide leeway that a designer has in this way, as well as by a choice of variable ratio between the moments of inertia of the girder and beams. A special case is considered where the beams have stanchions down to a center vertical keelson of the ship, of which the elastic deformation is established with resulting change in the forces deflecting beams and girder. In an appendix a quite detailed account is given of the graphical method used. The deflections and their originating forces are represented in diagrammatical form by ellipses of elasticity which may be constructed for any part or weight of girders or beams, and combined into total ellipses from which the varying deflections of the points of, say, a curved beam can be found. After discussing the case of a beam rigidly

held at one end, the author points out in a general way that ellipses of elasticity can be combined in the same manner as ellipses of moments of inertia, clearly indicating in detail the way in which the deflecting forces and their variations were found in the main diagram of the longitudinal girder. 14 illustrations. 4,900 words.—*Schiffbau,* July 14.

Experimental Methods of the German Government Model Tank, Berlin. (Continuation of article published May 12 and 26 and reviewed in our August issue.)—In this instalment the author shows that for ships exerting a towing pull the race augment and wake gain at the varying speeds in question are more or less constant, which leads to convenient formulas for propeller efficiency and, what the author calls, slip constant, power constant and towing efficiency constant. From the recorded results deductions can be made for six cases: increased towing pull; increased speed; same load at variable speeds; different diameters of propeller; deduction of diameter, slip, horsepower and pull from propeller efficiency. Numerical examples for the six cases are worked out, and the results recorded give full insight into the problem of selecting an efficient tug for a given task, leaving only modifications to be determined by financial and commercial considerations of cost and installation. The next chapter is devoted to propeller efficiency pure and simple, based upon runs with the propeller model without the hull. The thrust, torsional moment and efficiency are determined and recorded for different slips. As an example, an application is made to a twin-screw tug considering the race augment and wake gain. The next chapter deals with propeller experiments constituting a logical development from variable factors of pitch and area ratios. 7 illustrations. 5,400 words.—*Schiffbau,* June 26.

Experimental Methods of the German Government Model Tank, Berlin (Continuation of above).—This article takes up a series of twenty propellers, four each of varying pitch ratio in five groups of varying area ratios. The results are compiled in the form of diagrams from which selections can be made for a propeller to cover given conditions. Two premises are considered: either the diameter is given or the revolutions are given, and an example is worked out for a twin screw motor boat of which the effective horsepower curve is given for progressive speeds. The first case with a given propeller diameter is again further elaborated by also assuming a fixed pitch ratio of 1. Another example is given for a twin screw tug as well as for a single screw tug under altered conditions of slips up to 80 percent and area ratios up to 60 percent in changing the factors in four combinations which in the form of a table show all the important results, with the conclusion for the special conditions that under a towing pull of 4,400 pounds at a speed of nearly three knots, a small pitch ratio, a large diameter and twin screws prove the most desirable. 5 illustrations. Two tables. 3,800 words.—*Schiffbau,* July 14.

The Evolution of the Oil Tank Ship.—By Herbert Barringer. Although there is no written history of the earliest bulk oil carrier, the Chinese Newchwang junk, which was fitted with an expansion trunk and was originally built for the carriage of water in bulk, but afterwards used for oil, must be among the earliest examples of this class of vessel. There is also a record that special instructions were issued as to the carriage of oil up the Volga about the year 1723, and in 1754 the Persians collected oil on Holy Island (near Baku) and conveyed it in sailing vessels, evidently in bulk. These early examples of bulk oil carriage were not much improved until 1875, when the first organized attempt to transport petroleum without the use of tanks or barrels was made by Nobel on the Caspian. In 1878 the first steamship, the *Zoroaster,* was adapted for carrying oil in bulk. The tanks in this vessel were cylindrical in form. The steps by which the present tanker has been evolved are briefly as follows: (1) The introduction of longitudinal and transverse bulkheads, (2) the fitting of expansion trunkways, (3) the provision of cofferdams forward and aft of the cargo tanks, (4) the carriage of oil direct to the skin of the vessel without the use of independent tanks, (5) the abolition of the cellular water ballast double bottom below the cargo tanks, (6) the building of pump rooms extending the whole breadth of the vessel and carried down to the bottom plating of the ship and up to the upper deck, (7) the fitting of compound hatches in order to deal with the carriage of other cargoes than liquid ones, (8) the perfection and elaboration of pumping arrangements, (9) the fitting of mechanical ventilation to tanks, (10) the fitting of steam heating coils in the cargo tanks, and (11) the introduction of liquid fuel in place of coal. Brief descriptions of types of vessels representing various periods in the development of the present-day oil tank steamship are given. It is pointed out that under present circumstances the steam engine is still the most reliable propelling machinery for this type of vessel, although it is conceded that eventually, when mechanical difficulties have been overcome, the internal combustion engine in some form will, to a great extent, displace the steam engine in tank vessels. 2,000 words.—*The Shipbuilder,* July.

The Large Steam Collier Rose Castle.—A description of one of the latest large steam colliers, built by Messrs. Short Bros., Ltd., of Sunderland, to the order of the Rose Castle Steamship Company, Ltd., Liverpool, for the coal trade between Sidney, C. B., and Montreal. The vessel is an Isherwood-framed, single-decked steamer with poop, two short bridges and topgallant forecastle, with the propelling machinery placed amidships. A cellular double bottom used for water ballast and fresh water extends the full length and, in addition, fore-and-aft peaks and wing tanks are provided for ballast when the ship is in light trim. There are seven transverse watertight bulkheads and one steel cross bunker bulkhead. The cargo space is divided into five holds. The length of the vessel overall is 470 feet; between perpendiculars, 455 feet; breadth, extreme, 58 feet; the depth, molded, 33 feet 9 inches; underdeck tonnage, 6,893.85; gross tonnage, 7,545.78; net tonnage, 4,351.28; load draft, 25 feet 6 inches; load deadweight, 11,220 tons; capacity of cargo holds, 548,316 cubic feet; total water ballast capacity, 3,404 tons; bunker capacity, 1,032 tons. There are ten main hatches, two derricks being fitted to each hatch worked by ten 7-inch by 10-inch and two 8-inch by 12-inch steam winches, by which it is expected that the vessel when in service will load a full cargo of coal in six hours and discharge it by grabs in about the same time. Propulsion is by one set of triple expansion engines with cylinders 28½, 47 and 79 inches diameter by 54 inches stroke, supplied with steam by three Scotch boilers 16 feet 1½ inches diameter by 12 feet feet long, fitted with Howden's forced draft and working at 180 pounds per square inch. When developing 3,500 indicated horsepower, the vessel is expected to average 10½ knots. 4 illustrations. 1,400 words.—*The Shipbuilder,* July.

Shipbuilding and General Marine News

**Contracts for New Ships—Marine Terminal Improvements—
Recent Launchings—Improved Appliances—Personal Items**

During the month several additional orders for large oil tank steamships have been placed in American shipyards, bringing the total deadweight tonnage of oil tankers now under construction in this country close up to 300,000 tons as against over 200,000 tons recorded last month. In addition to the orders mentioned below the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., has received an order for two large oil tankers, one a 10,000-ton ship for the Sun Oil Company, Marcus Hook, Pa., and the other for the Union Oil Company, San Francisco, Cal.

Another important feature of the orders placed during the month is a contract for two steam colliers placed with the New York Shipbuilding Company, Camden, N. J., one of which will be the largest collier ever built in the United States for merchant service.

On account of the rush of orders placed in the Atlantic shipyards, filling them up to capacity for months to come, the New York & Cuba Mail Steamship Company (Ward Line), which has been in the market for some time for a 6,000-ton steamship for the New York and West Indies service, was obliged to place the order for this ship on the Pacific coast in order to insure delivery within reasonable time. The Seattle Construction & Dry Dock Company, Seattle, Wash., secured the order.

Recent Shipbuilding Contracts

The Harlan & Hollingsworth Corporation, Wilmington, Del., has received a contract from the Standard Oil Company, New York, for two tank steamers, each to be 425 feet long and to cost about $500,000 (£102,500).

The Harlan & Hollingsworth Corporation has received a contract from the Wilson Line, Philadelphia, Pa. (Philadelphia & Wilmington Steamboat Company), to build a passenger steamer 192 feet long, to cost about $250,000 (£51,250).

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has received a contract from the Standard Oil Company of New Jersey, Bayonne, N. J., to build two tank steamers about 500 feet long.

The Union Iron Works, San Francisco, Cal., has received a contract from the Standard Oil Company of New York for an oil tank steamship 440 feet long, to cost over $1,000,000 (£205,000).

The Wm. Cramp Ship & Engine Building Company, Philadelphia, Pa., has a contract from the Florida East Coast Railway Company, St. Augustine, Fla., to build a steel car ferry which is to be a duplicate of the one which this company built for these owners last year.

The Fore River Shipbuilding Corporation, Quincy, Mass., has received a contract to build a transport for the Argentine Republic.

The Slidell Dry Dock & Shipbuilding Company, Slidell, La., has received a contract from the Mobile Coal Company, Mobile, Ala., to build six barges.

The Collingwood Shipbuilding Company, Ltd., Collingwood, Ont., Canada, has booked an order for two oil tank steamships, 250 feet long, 43 feet beam and 18 feet molded depth to the main deck, for Canadian owners. These ships will be equipped for service either on the Great Lakes or on the ocean and will have a continuous expansion trunk 7 feet 6 inches high running practically the whole length. In each ship there are ten main oil tanks and four lubricating oil tanks, also an oil tank bunker in addition to a coal bunker, as the vessels will be arranged so that either system of fuel can be adopted. The pump room is located forward of No. 1 tank and a small hatch is situated immediately forward of this. Between the first and second tank there is a cofferdam arranged so that gasoline (petrol) can be carried in the two foremost tanks while crude oil can be carried in the remainder, or vice versa. The propelling machinery consists of triple expansion engines and Scotch boilers designed to give the vessels a speed of about 8 knots. The pumping installation and piping is being given special consideration in order that the cargo may be discharged in a very short space of time; separate pumps and piping will be installed for taking care of the lubricating oil. Both ships will be delivered at the opening of navigation next year and both will be built to Lloyd's highest class.

Shipbuilding Contracts Pending

It is reported that W. R. Grace & Company, Hanover Square, New York, will soon receive bids for the construction of a steel steamer to cost about $800,000 (£164,000).

Plans for the six torpedo boat destroyers authorized by the last Congress have been perfected, and bids for their construction will be opened on October 6. These destroyers will have a maximum speed of 30 knots, will displace 1,135 tons and will be 310 feet long.

Shipyard Improvements

It is stated that the Maryland Steel Company, Sparrows Point, Md., has let, or is about to let, contracts for improvements to cost approximately $1,000,000 (£205,000), including a new ways to be 700 feet long, a new machine shop, an extension to the boiler shop and other improvements.

The Hanlon Dry Dock & Shipbuilding Company, San Francisco, Cal., is building a new dry dock and shipbuliding plant on the Oakland inner harbor. It is reported that this dock will have a capacity of 3,500 tons. The new plant will have equipment for shipbuilding and ship repair work.

It is reported in Savannah, Ga., that a large shipbuilding plant will be built in that city. A bill has been introduced in the Georgia Legislature upon the passage of which the building of the plant is said to depend.

Marine Terminal Projects

The Baldwin Locomotive Works, Philadelphia, Pa., is said to have made application for permission to build a large pier on the Delaware River at the foot of the company's property at Eddystone.

The city of Dunedin, Fla., will vote on September 4 on bonds to construct a pier.

The Savannah Dock & Warehouse Company has been organized at Savannah, Ga., with a capital of $100,000 (£20,500) to erect wharves, docks, etc.

The city of Savannah, Ga., will erect a municipal pier and warehouse. Nisbet Wingfield is city engineer.

United States Destroyer Tender *Melville*, Recently Completed by the New York Shipbuilding Company, Camden, N. J., for the Navy Department. Propelling Machinery Consists of Parsons Turbines, Driving Through Westinghouse Reduction Gear

Horton & Horton, Houston, Tex., have received a contract from the city of Houston to construct a wharf, cotton sheds, etc., at a cost of about $139,000 (£28,500).

The Houston Terminal Warehouse Company, Houston, Tex., will soon build a dock.

The city of Orange, Tex., has voted $325,000 (£66,700) in bonds for the construction of wharves and docks.

The Carolina Pier Company has been organized at Wilmington, N. C., to build a pier. W. A. McGowan is president.

Charles R. Forbes, chairman of the Board of Harbor Commissioners, Honolulu, T. H., will receive bids on September 22 for the construction of several reinforced concrete piers.

The Georgia Contracting Company, Augusta, Ga., will build a reinforced concrete wharf and warehouse for the city of Augusta.

Charles Campbell, city engineer, St. Joseph, Mo., is having plans prepared for the construction of a dock.

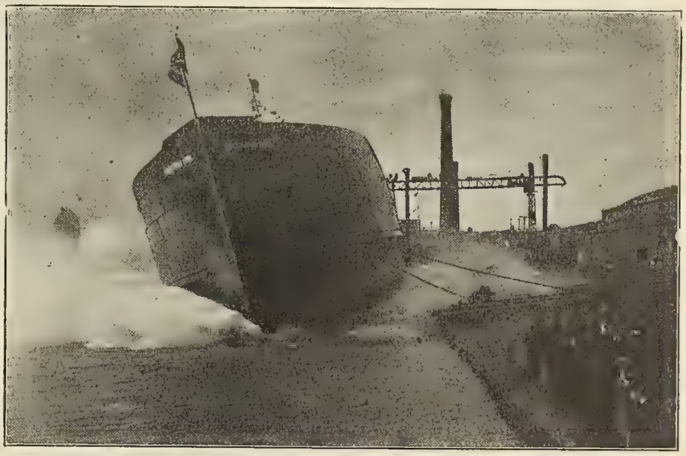
The Standard Oil Company of New Jersey, Bayonne, N. J., will, so it is reported, build a dock at Bayonne.

New Barge Line Incorporated

The Gulf Export & Transportation Company, capitalized at $100,000 (£20,500), all of which is stated to be paid up, has been organized at Beaumont, Tex., to conduct a barge line to be operated between Beaumont and Tampico, Mexico. W. A. Boyie, of Tampico, is president of the organization; C. Christofferson, of Beaumont, is vice-president, and W. E. Sprouse, of Houston, is secretary-treasurer and will be manager of the Beaumont office. Three barges are under construction at Pensacola, Fla., and the *Pilot*, a 150-foot vessel, has been acquired and has been fitted for burning oil.

Another Side Launching on the Great Lakes

Side launchings are universal on the Great Lakes, due to the fact that the shipyards are generally located within the harbors of large ports or on adjacent rivers, and consequently, due to the limited space available, end launching is out of question. In this manner the steel twin-screw car ferry *Ontario* No 2, was launched at the yards of the Polson Iron Works, Ltd., Toronto, on April 3.



Launching of Car Ferry *Ontario No.* 2 by Polson Iron Works, Ltd., Toronto, April 3, 1915

This ferry is of the shelter deck type, 318 feet long and 54 feet beam, and is built with solid plate floors and extra heavy scantlings. She is equipped with transverse and longitudinal bulkheads and has a gross tonnage of 5,400. Plymouth manila ropes 3 inches and 5 inches in diameter were used for launching triggers and mooring lines.

Ontario No. 2 will have a capacity of thirty loaded cars

and a thousand passengers and will connect the Grand Trunk and Buffalo, Rochester and Pittsburgh railroads between Cobourg, Ont., and Charlotte, N. Y.

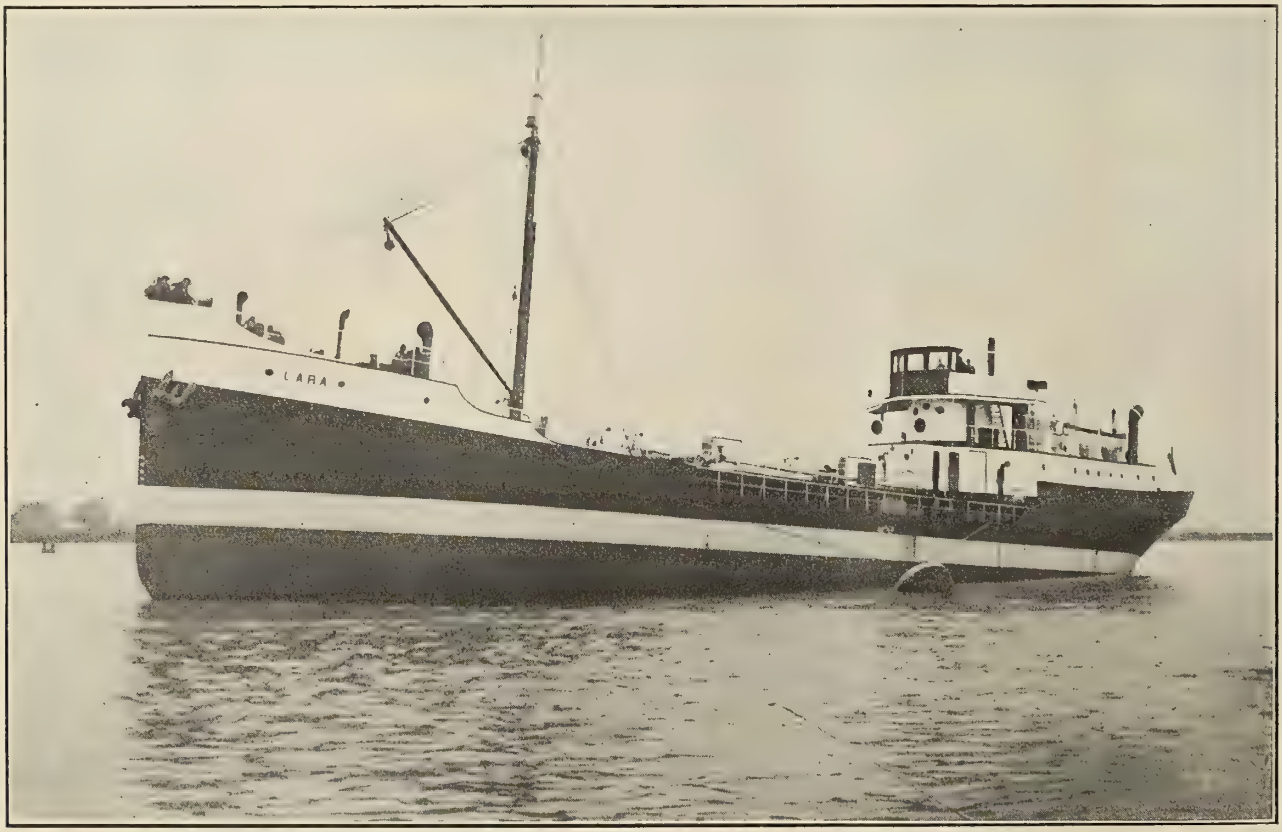
New Motor Ship Lara

Although to some considerable extent the manufacture of war materials is delaying the progress of motor ship construction, particularly in England, there are several European Diesel engine concerns that are very busy, among whom are the Werkspoor Company, of Amsterdam, and the most recent vessel that they have equipped with motor power is the *Lara,* while the Werkspoor-Diesel ships *Siberg, Utrecht* and *Boelongan* will shortly be sent out from their works for their trials.

The *Lara* is a small tanker that has just been built for the Anglo-Saxon Petroleum Company, and makes the eighth Werkspoor, four-cycle engined boat that this important oil concern has taken delivery of during the six years since they first ordered the *Vulcanus,* a 1,000-ton deadweight capacity Werkspoor-engined tanker of 500 horsepower, and which has since been in regular service, effecting a saving of about $11,000 (£2,250) per annum for her owners. The *Lara* is of but 875 tons deadweight capacity, but this is considerably more than the capacity of a steamship of similar dimensions; so, apart from the economy effected by the low fuel consumption of about 0.3 pound per indicated horsepower, the advantage of the increased tonnage will be apparent to shipowners.

Her length is 190 feet overall by 32½ feet beam, 14 feet molded depth and 11 feet 9 inches draft. The engine is a six-cylinder, four-cycle type Werkspoor Diesel of the directly-reversible class, developing 650 indicated horsepower at 175 revolutions per minute. This speed is, of course, considerably higher than the higher powered Diesel engines of the same make, which turn at 100 to 125 revolutions per minute, according to the power.

In America it is generally thought that high-powered marine Diesel engines are more expensive than domestic built steam engines and boilers, but the contrary is the real position, and the makers of the engine of the *Lara* can deliver such engines at their works at prices from 30 to 40 percent lower.



Werkspoor-Diesel-Engined Oil Tanker *Lara,* Recently Built for the Anglo-Saxon Petroleum Company

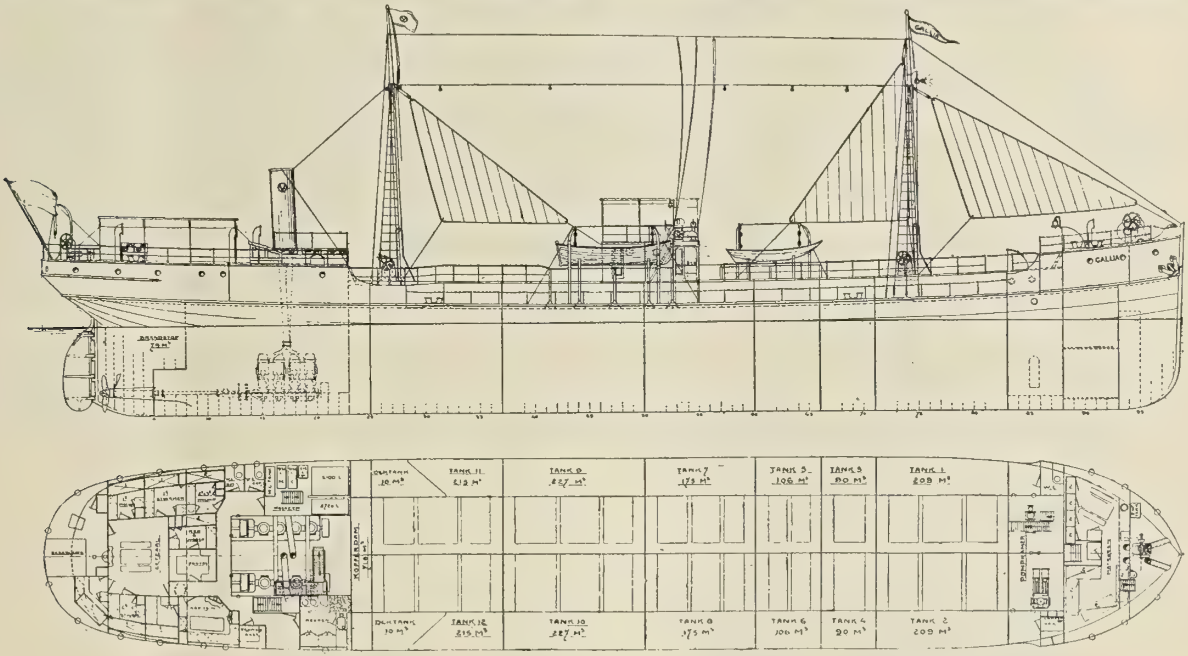
Motor Ship Gallia

At the time she was built, early last year, the motor ship *Gallia,* illustrated on the opposite page, was the highest powered motor vessel in which hot bulb engines of the Bolinders type had been installed. Since then other vessels have been built in which the power equals or exceeds that of the *Gallia.*

The *Gallia* was built in Holland as an oil tank vessel for Messrs. P. van Ommeren, of Rotterdam, and is 190 feet long, 33 feet 6 inches beam and 18 feet depth, with a load draft of 16 feet 4 inches. Her deadweight carrying capacity is 1,630 tons and she is propelled by two 320 brake horsepower, four-cylinder Bolinders direct reversible engines operating at a normal speed of about 225 revolutions per minute. The motors were supplied by Messrs. Becker & Co., of The Hague, and Bolinders engines were also supplied for operating the windlass and for operating the air compressor and steering gear. Both of these auxiliary engines were of 10 brake horsepower.

The total machinery weight is about 61 tons, and, as can be seen from the photographs, the machinery installation occupies a comparatively small space, giving ample room between the two engines. There are two separate silencers for each engine—one for each pair of cylinders. The exhaust pipes are joined and lead up through the

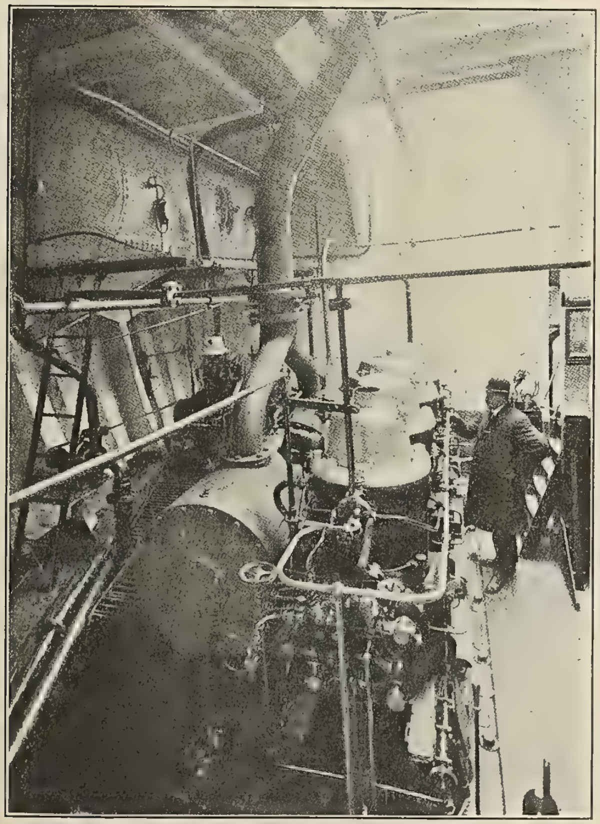
funnel. The crude oil consumption of the engines with the vessel running on long trips, fully loaded, at about eight knots speed, was .55 pound per brake horsepower per hour. The owners report that the engines maneuver very easily and quickly and do not race in rough weather. Two similar Bolinders installations have recently been made consisting of twin screw sets of two 320 brake horsepower engines each for the motor ships *Drente* and *Limbung*. Another important installation of Bolinders engines has been made in the auxiliary yacht *Belem*, purchased by the Duke of Westminster.



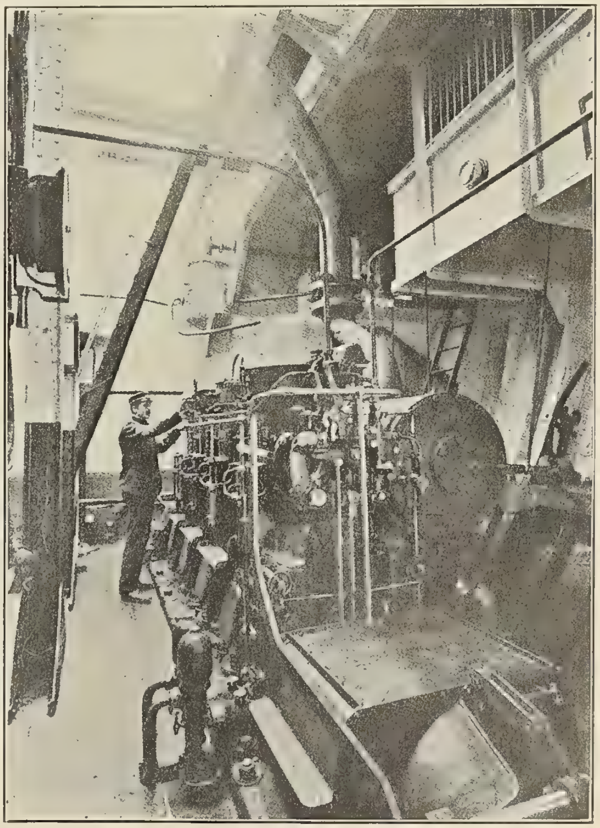
Plans of Motor Tank Ship *Gallia*, Fitted with Two 320 Horsepower Bolinder Oil Engines

Recent Launchings

Among the vessels launched during the last month were the steam collier *Franklin*, under construction at Camden, N. J., by the New York Shipbuilding Company; the government hydraulic hopper dredge *San Pablo*, which is being built by the Baltimore Drydocks & Shipbuilding Company, Baltimore, Md.; the torpedo boat destroyer *Porter*, at the yards of the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., and two of the ten submarines which the Fore River Shipbuilding Corporation is building at Quincy, Mass., for Great Britain.



Port Engine

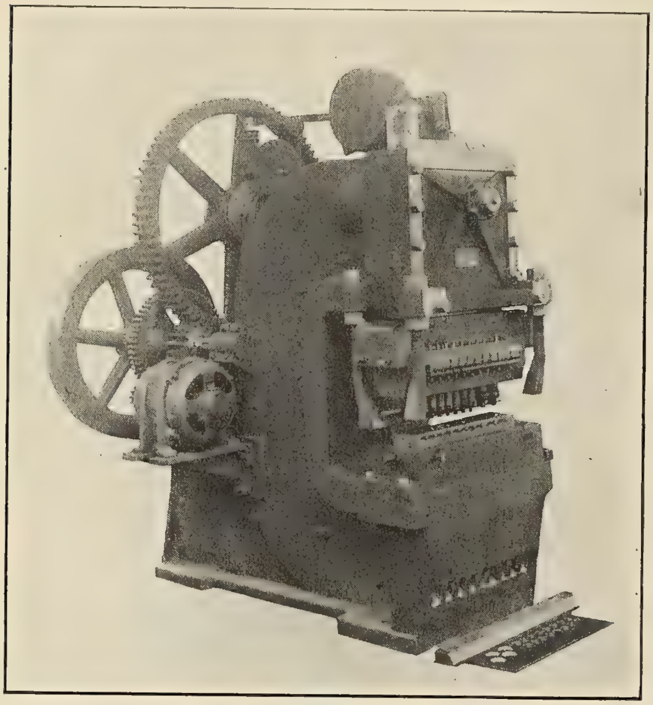


Starboard Engine

ENGINEERING SPECIALTIES

Multiple Punch with New Features

The illustration shows a new multiple punching machine recently designed and built by Bertsch & Co., Cambridge City, Ind. It has a cored or box section frame. There are twenty punching units in the head, each one of which

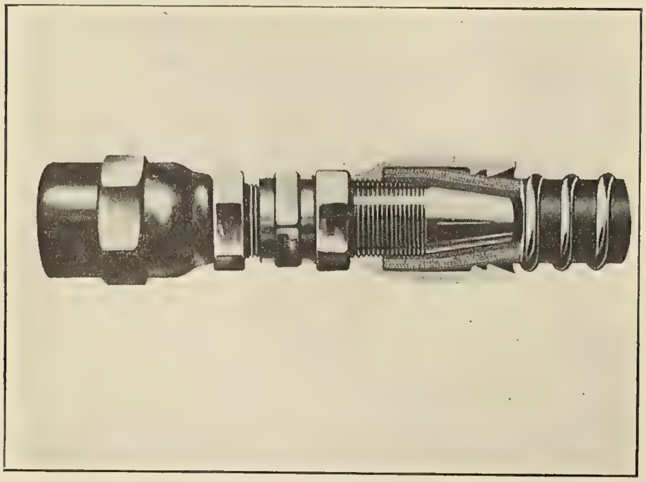


Multiple Punch with Special Couplings

is gaged so that any number of punches from one to twenty can be either used or disengaged, as desired. Sixteen of the punches were too close together for standard couplings; therefore special couplings were used, clearly shown in the cut, on which the builders are applying for a patent.

Coupling for Compressed Air Hose

The National hose coupling, manufactured by the National Hose Coupling Company, Peoples Gas Building,



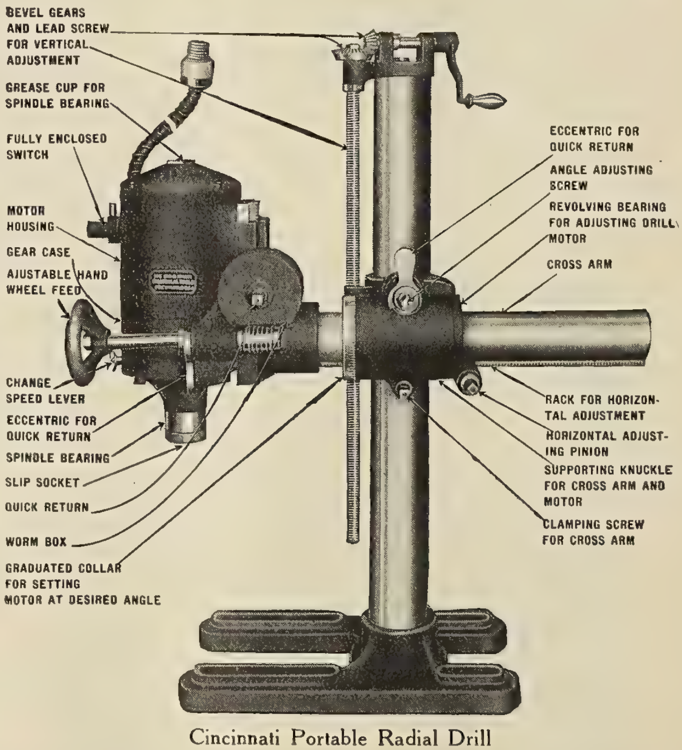
National Hose Coupling

Chicago, Ill., has been designed to eliminate the necessity of special clamps to effect a grip on the ends of the hose. The coupling consists of a malleable iron hose socket, sufficiently corrugated on the inside to provide a positive grip when the hose is expanded by screwing into the socket a steel taper expander which forces the hose outward and into position. No attempt is made to contract the outside of the hose, but all the stress is applied from the inside. The hose readily enters the socket and may be cut and recoupled as often as required. The edge of the socket and the end of the expander are smoothly rounded to prevent injury to the hose. A single wrench suffices for adjusting the coupling, making the operation of connecting or disconnecting simple and convenient.

Cincinnati Portable Scotch Radial Drill

A handy tool which is in general use in machine shops, construction work, navy yards, arsenals and on board naval vessels is manufactured by the Cincinnati Electrical Tool Company, Cincinnati, Ohio, known as the "Cincinnati" improved type portable electrical Scotch radial drill. Driving power is obtained from an ordinary lamp socket, so the tool can be used wherever electric power is available.

The motor drill and the knuckle have a vertical adjustment on the upright column by means of a worm and



Cincinnati Portable Radial Drill

worm wheel through a 34-inch lead screw and a horizontal adjustment by means of a rack on the cross arm and pinion in the knuckle. The revolving bearing in the knuckle which supports the cross arm has a graduated collar, so that the operator can set the drill at any desired angle. This is done by means of the worm and worm wheel in the knuckle, which also prevents the motor from turning or dropping while adjusting it.

The motor is of a heavy duty type, air cooled, fully enclosed and dirt and dust proof. It can be set at any angle and has a circle radius of 24 inches. It has a 10-inch feed through a hand wheel with quick return. The hand wheel and worm box are adjustable to drill in either

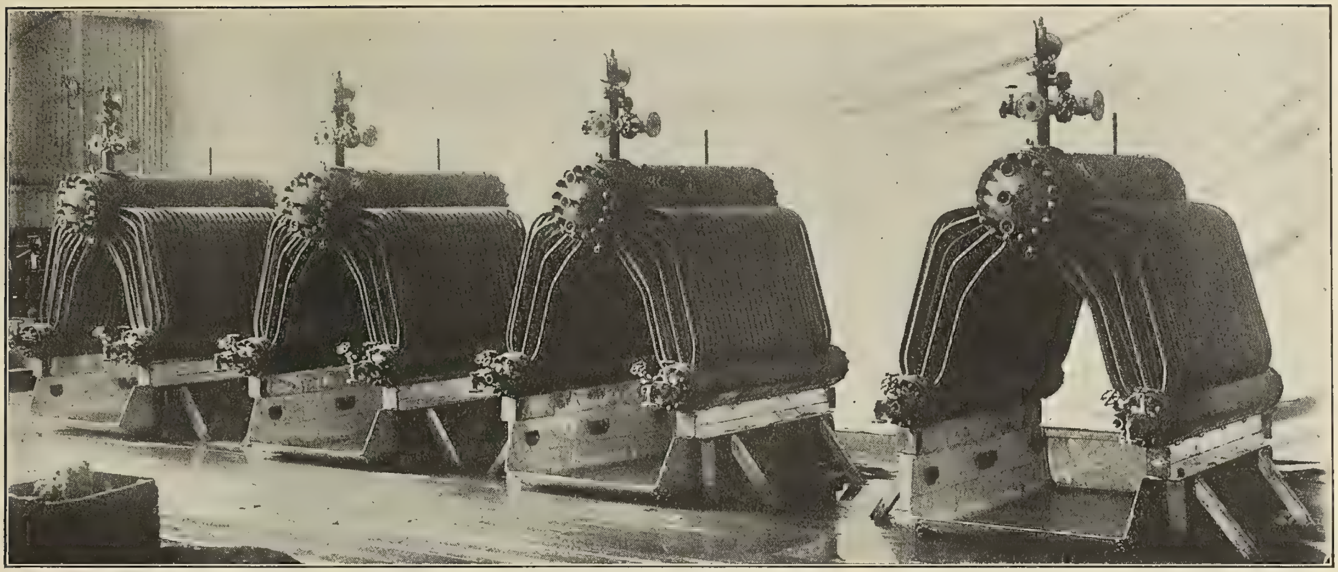


Fig. 1.—New Type Navy Boilers, Built by Charles L. Seabury & Company, Morris Heights, New York

a horizontal or vertical position, allowing the operator to get into close corners. All adjustments it is claimed, are positive and under immediate control. The motor is equipped with a special type slip socket, doing away with the drift key and drift holes in the spindle and spindle bearing, preventing dirt and borings getting into them.

This drill is made in three sizes, 1¼, 2 and 2½-inch capacities, with single and two speeds.

New Type Navy Boiler

The eight boilers recently purchased by the Navy Department under Navy Schedule 7865, class 141, have been delivered by Charles L. Seabury & Company, of Morris Heights, New York City, after passing every test. Four of these boilers are illustrated in Figs. 1 and 2. They are of the "Seabury" safety watertube type, designed to operate under 165 pounds steam pressure, though a hydrostatic pressure of 500 pounds was successfully applied. The dimensions are as follows:

Length of casing, 4 feet 3½ inches; width, 4 feet 4 inches; height, including ash pan, 5 feet 6½ inches; grate surface, 12.5 square feet, and heating surface, 240 square feet. The upper or steam drums were of 15 inches outside diameter, lap-welded steel plate ½ inch thick, and the lower or mud drums were of the same material, 8⅝ inches outside diameter, and 5/16 inch thick. The generating tubes were of 1 inch O. D., No. 12 B. W. G. of seamless drawn steel cold bent to shape.

The boilers were fitted with flanges, in accordance with the Bureau of Steam Engineering Standard Flange List No. 8-A, and complete with fittings and casing, weighed each, dry, 3,800 pounds.

Hanna Combination Yoke Riveter and Punch

The Hanna Engineering Works, 2059 Elston Avenue, Chicago, Ill., has recently placed upon the market the combination yoke riveter and punch illustrated. As a riveter this machine is well known and is being extensively used in the fabrication of steel throughout the country. A description of a 100-ton riveter of this type appeared in the May issue of International Marine Engineering. The machine illustrated is arranged with special die and anvil for punching flanges of 6-inch to 10-inch channels. An

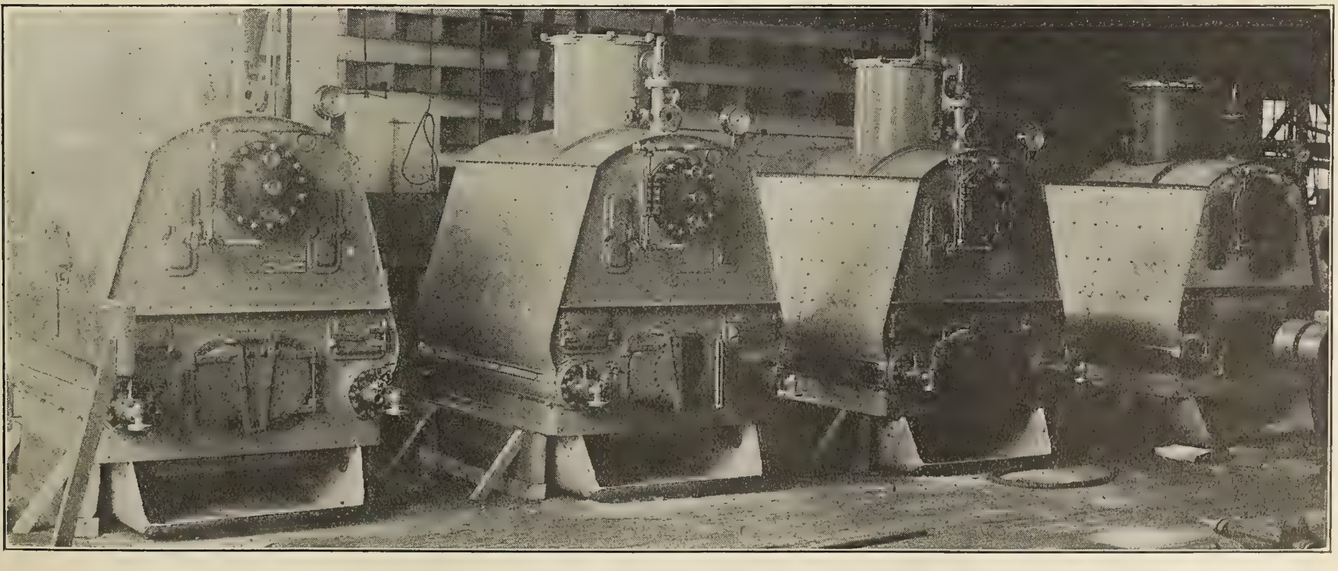
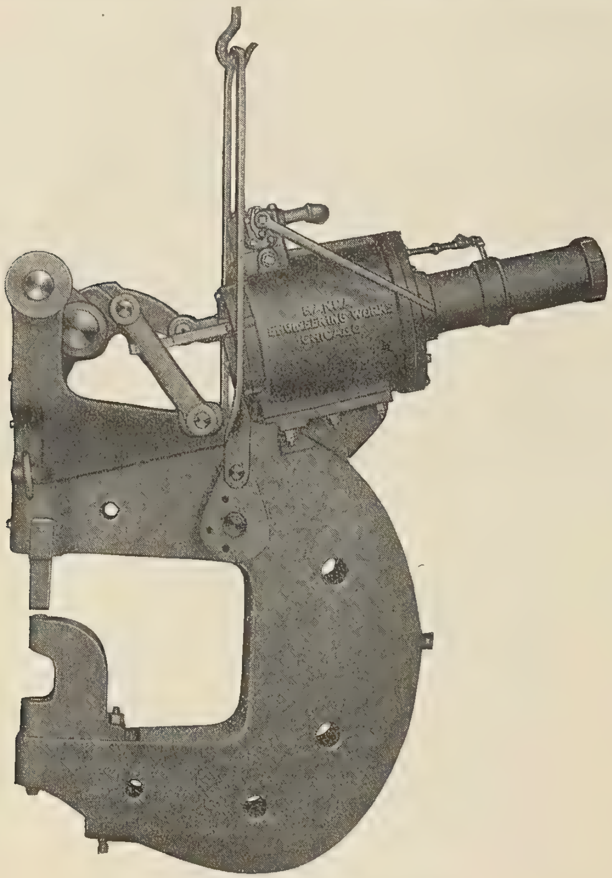


Fig. 2.—Four of New Type Navy Boilers Complete, With Casings and Fittings

auxiliary dash-pot mechanism automatically absorbs all shock after the die has passed through the plate. For punching bent ship channels, it is claimed, the machine



Hanna Yoke Riveter and Punch

will effect considerable savings in time and labor over the usual method of routing this work through the shop.

The punch or rivet die in this machine is operated through the combined toggle and simple lever motion which is characteristic of all Hanna pneumatic riveters.

PERSONAL MENTION

Operating Engineers

Alex. Rehnberg has been appointed chief engineer of the steamship *San Marcos*.

James Lawton is chief engineer of the American-Hawaiian steamer *Ohioan*.

G. J. Perry, of New Orleans, La., has been appointed first assistant engineer of the steamer *Morse*.

Cyrus C. Yarter has been appointed first assistant engineer of the tug *Yosephie*, Schenectady, N. Y.

D. W. Cross, of New Orleans, La., has been appointed first assistant engineer of the steamer *Santurce*.

A. W. Baird, of New Orleans, La., has been appointed third assistant engineer of the steamer *Mexicano*.

D. W. Grace, of New Orleans, La., has been appointed second assistant engineer of the steamship *Santurce*.

George McCord, of New Orleans, La., has accepted the position as chief engineer of the steamship *McDougall*.

William Pilante, of New Orleans, La., has been appointed second assistant engineer of the steamer *Mexicano*.

Samuel J. Ryan has been appointed chief engineer of the tug *Yosephie*, engaged on barge canal work at Schenectady, N. Y.

Henry Ryan has been appointed second assistant engineed of the steamer *Berkshire*, of the Hudson Navigation Company, New York.

Winnie Norris has been appointed first assistant engineer of the steamer *Greenport*, of the Hudson Navigation Company, New York.

George W. Morey has been appointed chief engineer of the steam tug *Betty*, used at the State Dam on the Hudson River at Troy, N. Y.

George Mason, formerly chief engineer of the steamship *San Marcos*, has been appointed chief engineer of the steamer *San Jacinto*, vice George Ross, deceased.

Chris Jadatz, first assistant engineer of the steamer *Berkshire*, of the Hudson Navigation Company, has accepted a position at the Keeler Hotel, Albany, N. Y.

Paul Maltias recently resigned on account of illness from the position of first assistant engineer of the steamer *Greenport*, of the Hudson Navigation Company, New York.

James Andus has been appointed chief engineer of the steamer *St. Johns*, of the Potomac & Chesapeake Steamboat Company, Washington, D. C., with James Nash as his assistant.

Henry Stammell, of the tug *James A. Morris*, at Albany, N. Y., has been appointed chief engineer of the steamer *William H. Kinch*, of the Great Lakes Dredge & Dock Company.

S. P. Hinckley is chief engineer of the steamer *Pacific*, which recently sailed from New York to Pacific ports. F. Daly is first, P. P. Hinckley second and E. A. Lewis third assistant engineer of this vessel.

Hubert Dicks has been appointed chief engineer of the Lake-built steamship *Arlington*, now fitting out at the Newport News Shipbuilding & Dry Dock Company for the New England Coke & Coal Company, of Boston, Mass.

George B. Langin is chief engineer of the new tug *Mary M.*, employed by the Randerson Construction Company, Albany, N. Y. This tug was formerly called the *Chester* and was recently thoroughly rebuilt at Albany, N. Y.

George C. Glazer, second assistant engineer of the United States lighthouse steamer *Orchid*, has been transferred to the lighthouse steamer *Laurel*, succeeding H. D. Reilly, who has been transferred to the lighthouse steamer *Holly*.

William Lambert is chief engineer of the steamer *Charles H. Werner*, which arrived in Washington on July 31, under charter to run excursions to River View for the balance of the season. Captain John Mills is in command of this vessel.

P. J. Killian, chief engineer of the government tug *Colonel Thayer*, has resigned to accept a position with the Great Lakes Dredge & Dock Company, Albany, N. Y. James Hayes has been appointed chief engineer of the *Colonel Thayer*.

J. R. Cohen is chief engineer of the steamer *El Cid*, which recently underwent repairs at Tietjen & Lang's yard, Jersey City, N. J. C. E. Davidson, W. C. Dowe and W. W. Adams are first, second and third assistant engineers respectively on this vessel.

George Smith, chief engineer of the steamer *St. Johns,* of the Potomac & Chesapeake Steamboat Company, Washington, D. C., has been transferred to the steamer *Volunteer* of the same company, to superintend the repairs occasioned by a recent fire on this vessel.

John Carey, chief engineer of the steamship *William H. Kinch,* has been appointed first assistant engineer of the *Berkshire,* of the Hudson Navigation Company, New York. Mr. Carey was formerly first assistant engineer of the steamer *C. W. Morse,* of the Hudson Navigation Company.

M. A. Parker, formerly chief engineer of the steamer *Peter H. Crowell,* of the Crowell & Thurlow Company, Boston, Mass., has been appointed chief engineer of this company's new steamer *W. D. Noyes,* recently built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va.

J. H. McNamara is chief engineer of the Virginia oyster police steamer *Phillips,* which has recently been brought to the wharf of Messrs. Forsberg & Murray for extensive repairs to her boilers and machinery and to have new water tanks installed. Captain O. W. Hudson is in command of this vessel.

L. C. Potteiger is in charge of the engine room of the steamer *Castle,* of the United States Army Engineer Service, which was recently sent from Washington, D. C., to Urbanna, Va., at the mouth of the Rappahannock River, where the government dike, built to protect the dredged channel leading into Urbanna, is being repaired. Engineer Harrison, from the office of Colonel Newcomer, engineer officer in charge of this district, is in charge of this work.

Naval Architects, Consulting Engineers and Shipyard Officials

Colquhoun F. Grant, for seventeen years senior assistant superintendent engineer of the Clan Line of steamships, London, has been appointed superintendent engineer of this line, vice John Lyall, deceased.

G. M. Bosworth has been elected chairman of the Canadian Pacific Steamships Company, Ltd., at Montreal, and H. Maitland Kersey has been appointed managing director of the company, with offices in London.

G. B. McAlpine, for the past sixteen years employed in the hull drafting department of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has been appointed hull inspector of the Lake Torpedo Boat Company, Bridgeport, Conn.

Commander H. I. Cone, U. S. N., formerly chief of the Bureau of Steam Engineering and recently commander of the torpedo flotilla tender *Dixie,* was assigned on July 27 to the Panama Canal as marine supsrintendent, succeeding Captain Hugh Rodman, ordered home to await orders.

Captain Albert Weston Grant, U. S. N., was recently appointed by the Secretary of the Navy as head of the United States submarine service. Captain Grant's headquarters are at present on the old cruiser *Columbia,* which is now the mother ship of submarines at the Philadelphia Navy Yard.

Homer L. Ferguson, formerly general manager of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has been elected president of this company, vice A. L. Hopkins, deceased. The following appointments have been announced by President Ferguson: F. P. Palen, assistant to the president, New York City; S. L. Wood, assistant to the president, Newport News; W. H. Benson, assistant to the president, Newport News.

C. C. Lacey, marine superintendent of the Great Northern Pacific Steamship Company, Seattle, Wash., resigned his position on July 1. Mr. Lacey was formerly marine superintendent of the Great Northern Steamship Company at Seattle and superintended the construction of the *Minnesota* and *Dakota,* built for this line at New London, Conn., in 1904. Mr. Lacey also superintended the construction of the fast turbine passenger and freight steamers *Great Northern* and *Northern Pacific* recently built by William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., for the Great Northern Pacific Steamship Company.

The secretary of the British Admiralty announced on July 5 that Admiral of the Fleet Lord Fisher of Kilverstone has been appointed chairman of the Inventions Board established to assist the Admiralty in coördinating and encouraging scientific effort in relation to the requirements of the naval service. Other members appointed to the central committee were Sir J. J. Thomson, O. M., F. R. S.; Hon. Sir C. A. Parsons, K. C. B., F. R. S., and G. T. Beilby, F. R. S. Members appointed to the panel of consultants which will advise the central committee included the following: Professor H. B. Baker, F. R. S.; Professor W. G. Bragg, F. R. S.; Professor H. C. Carpenter; Sir William Crookes, O. M., F. R. S.; W. Duddell, F. R. S.; Professor Percy Frankland, F. R. S.; Professor Bertram Hopkinson, F. R. S.; Sir Oliver Lodge, F. R. S.; Professor W. J. Pope, F. R. S.; Sir Ernest Rutherford, F. R. S.; G. Gerald Stoney, F. R. S., and Hon. R. J. Strutt, F. R. S.

OBITUARY

Robert A. Snyder, president of the Saugerties Steamboat Company, Saugerties, N. Y., died on July 27 at Saugerties, aged 79 years. Mr. Snyder was also president of the Saugerties Manufacturing Company, the First National Bank of Saugerties and other corporations.

David A. Wasson, who has contributed many interesting articles to recent issues of International Marine Engineering, died recently at his home in Colorado Springs, Col., aged 30 years. Mr. Wasson was a grandson of David Wasson, of West Brookfield, Me., a prominent shipowner and shipbuilder. The name of Wasson, before and during the Civil War and for years after, was widely known throughout the United States by shipping men. Before his health failed, Mr. Wasson lived at Kittery Point, Me., where his parents are still living. Mr. Wasson's father is also an artist and a writer of distinction.

Henry Alexander Mavor, a pioneer in electric lighting and electrical manufacturing in England, and one of the founders of the firm of Mavor & Coulson, Ltd., died at Mauchline, Ayrshire, July 16, aged 57 years. Mr. Mavor entered the electric lighting field in 1879, working under the direction of Mr. R. E. Compton and afterward installed the first electric lighting plant in Glasgow, from which the present municipal system has grown. In later years Mr. Mavor gave his attention to the manufacture of electrical apparatus, and he secured many patents on inventions relating to the electric propulsion of ships and carried out experiments with a 2,000-ton vessel which gained him wide recognition from naval architects and engineers. He was called into consultation in connection with the design and construction of the electrical propelling machinery for the U. S. collier *Jupiter.*

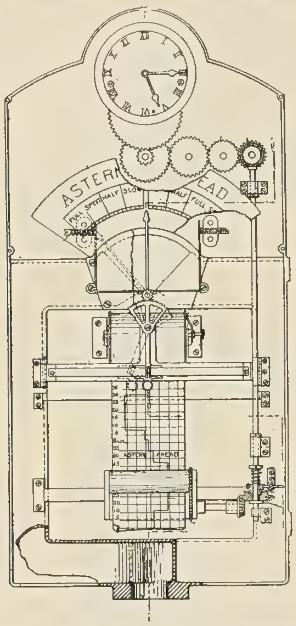
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Derbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,138,226. MARINE SPEEDOMETER. CHARLES H. KENNEY, OF NEW LONDON, CONN.

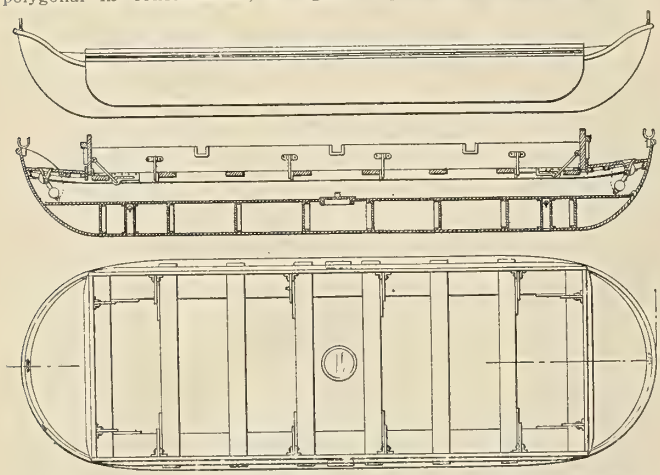
Claim 1.—In a marine speedometer adapted to indicate and record direction and speed ahead and astern by corresponding dips of a pointer and record diagrams, a case, an air duct in said case, a movable abutment in said duct adapted to be moved by varying air tension on opposite faces, a pointer operably connected with said movable abutment,



and thereby dipped in opposite directions to indicate respectively speed ahead and astern, a record tape, tape supporting means adapted to support said tape, tape-feeding means adapted to cause a feed motion of said tape, a marker adapted to mark said tape, and marker-shifting means operably connecting said movable abutment and marker and adapted to move said marker synchronously and in the same direction with said pointer. Eleven claims.

1,140,469. BOAT. ANDREAS P. LUNDIN, OF BAYSIDE, N. Y., ASSIGNOR TO WELIN MARINE EQUIPMENT COMPANY, A CORPORATION OF NEW YORK.

Claim 1.—A lifeboat comprising a metallic shell having a well, polygonal in conformation, air-tight compartments beneath the well,



marginal and cross seats connected to the shell at the upper edge of the well, a superstructure composed of rigid side and end members hinged to the shell and adapted to fold inwardly and means for automatically locking such side and end members when the same are moved into raised position. Five claims.

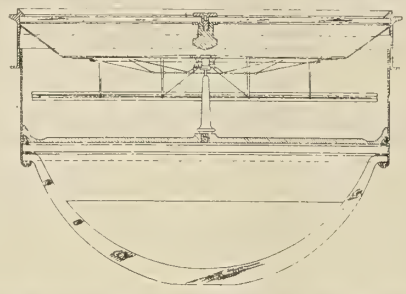
1,142,530. SCREW PROPELLER. WILLIAM ROWTHORNE, OF SOUTHAMPTON, ENGLAND.

Claim 1.—A screw propeller comprising blades, each having an annular, apertured hub-portion, of reduced thickness, and each blade having lateral shoulders at the hub end thereof, but not contained in the reduced portion; said hub portions being superposed to make a laminated hub for the propeller; and said shoulders of one blade abutting shoulders of adjacent blades. One claim.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

11,881/1914. IMPROVEMENTS IN OR RELATING TO MAGNETIC COMPASSES. M. B. FIELD, KELVIN; BOTTOMLEY & BAIRD, LTD., CAMBRIDGE STREET, GLASGOW.

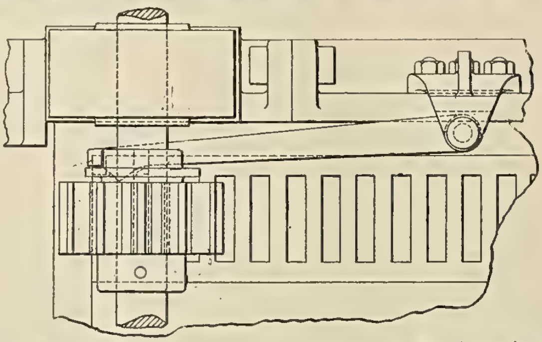
The primary object of the invention is the provision of a dry card having all-round attributes approximating as nearly as possible to those of the standard ten-inch card, but comprising an index of a diameter of about seven or eight inches, so disposed that it may be used in conjunction with a lubber point or a screen bearing a lubber mark, said point



or screen being attached to the bowl or bezel and brought into the immediate neighborhood of the index in such a manner that the card is free to tilt in relation to the bowl and *vice versa* without fouling said lubber mark or screen. A further object is to provide a sharp, truly circular and translucent edge to the index and so to support the latter that the silk threads usually employed do not underlie the degree markings of the index, so that when illuminated from below and viewed from a position vertically above (as is virtually the case when the optical system is used) the index graduations may be plainly seen.

15,770/1914. IMPROVED MEANS FOR RETAINING BULKHEAD DOORS IN THEIR OPEN POSITION. HARLAND & WOLFF, LTD., AND W. E. ARMSTRONG, QUEEN'S ISLAND SHIPBUILDING & ENGINEERING WORKS, BELFAST.

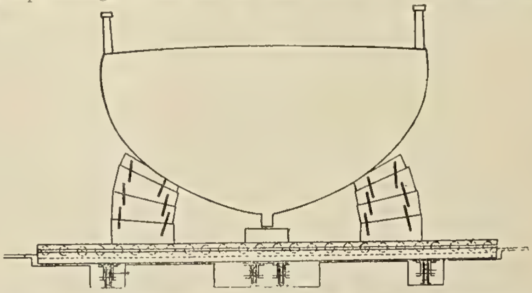
This invention relates to improved means for holding a bulkhead door in the open position and preventing it from moving when the ship rolls. It is especially suitable for use with a horizontally moving door actuated by means of a vertical shaft having on it a pair of spur pinions en-



gaging a pair of racks on the door. According to this invention there is provided a catch which is hinged to the door frame by a horizontal pin and is adapted to drop in front of a shoulder on the door when the latter is fully open, but to be lifted out of engagement with the shoulder by a cam on the shaft. The pinions are not fast on the shaft, so that when the shaft is turned to close the door it rotates through a small angle and thus causes the cam to lift the catch, and then it turns the pinions and opens the door.

15,661/1914. SLIPWAYS. S. H. GORDON, BRITON LODGE, TELFORD STREET, INVERNESS.

Claim.— A set of longitudinally disposed rails supporting a corresponding series of flanged wheels journaled in the main longitudinally moving slip carriage. The said carriage carries a set of rails disposed



transversely of the rails and constituting ball race co-operating with a series of balls contacting with a series of interconnected races supported by rails constituting a chassis for supporting the boat. Desirably the said balls are mounted in an interconnected series of cages, the ball-engaging surfaces of which are of synclastic formation so that the cage is supported by said ball, said cages being capable of disconnection so as, when the chassis is shifted, to be removable from the retreating side and be capable of being fed under the advancing side.

International Marine Engineering

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Ship Design Three articles in this issue deal with important problems relating to ship design. The first explains a method of determining the principal dimensions of merchant steamers, and is based upon the method outlined many years ago by Naval Constructor Woodward for the design of a naval vessel. The second is from a paper read before the International Engineering Congress by Rear Admiral D. W. Taylor, chief constructor of the United States Navy. This paper describes the application of mathematical formulæ to the determination of ships' lines, and shows the important part played by model tank experiments in the solution of problems relating to resistance, propulsion and rolling of ships. The third article takes up, from a thoroughly practical standpoint, the design of small screw propellers, a question that has become of vital importance since the general adoption of direct turbine drive in high-speed ships. In the solution of most problems of hull and propeller design the naval architect is greatly indebted to the work carried out at model experiment tanks, and shipowners are beginning to realize the economic value of expenditures made for experimental work of this kind. The mass of useful data from such investigations is daily increasing, but, unfortunately, much of it is inaccessible for general use.

The Spoils of War Two lists have been sent to our office showing the total number and aggregate tonnage of both merchant and war vessels lost during the first year of the European war. The accuracy of these lists cannot be vouched for beyond the fact that they were carefully compiled from reports taken from the *Manilla Bulletin, New York Herald, Berliner Tageblatt, London Shipping Record, North China Daily News, Hamburger Nachrichten* and *Ostasiatischer Lloyd.* A general summary of these figures, however, may be of interest to our readers. The list of merchant ships lost is taken from newspaper reports up to August 6, 1915, and that of warships from reports up to July 27, 1915. The grand total of both merchant and war vessels of all nations either captured or sunk during this period was 880 of 2,161,376 tons. These figures do not include vessels detained, except those of neutral nations. Of the vessels included in the above total, 566 of 1,395,446 tons belonged to the Allies, while 211 of 574,361 tons belonged to Germany, Austria or Turkey. The remaining ships, 103 of 191,567 tons, belonged to neutral nations. The general summary further states that the total number of merchant ships lost was 756 of 1,692,773 tons, of which 497 of 1,054,387 tons belonged to the Allies, as against 156 of 446,817 tons belonging to Germany and her allies. The warships lost by Great Britain, France, Russia, Italy, Japan and Belgium numbered 69 of 341,059 tons, while the warships lost by Germany, Austria and Turkey totaled 55 of 127,544 tons. At the outbreak of war 79 British steamers of 172,988 tons were detained in German ports, 102 German vessels of 200,000 tons were detained in British ports and 57 Austrian and German vessels were detained in Italian ports.

Marine Terminals It is not surprising to learn that at many of the marine terminals in the United States it often happens that the cost of loading and discharging vessels is greater than the actual cost of transporting freight on board ship between ports. This holds true more frequently in cases where the cargoes consist of miscellaneous package freight, and is due chiefly to the fact that little progress has been made in equipping American marine terminals with up-to-date machinery for the rapid and economical handling of this class of freight. Old and antiquated methods have been tenaciously adhered to in spite of the enormous increase in the volume of freight shipped from our ports and the result has been congestion and excessive costs.

The problem of reducing the high cost of the present methods of handling miscellaneous cargoes and of reducing the time required for loading and discharging vessels was discussed at length by Mr. H. McL. Harding, formerly consulting engineer of the Department of Docks and Ferries of the city of New York, in a paper read last month before the International Engineering Congress at San Francisco. The elements of a complete marine terminal, as described in this paper, consist of piers, slips, quays, railroad tracks and yards, sheds, warehouses, dray areas, open storage spaces and often public markets, cold storage buildings, coal pockets and manufacturing lofts, as well as sheds and warehouses for special commodities. For the economical handling of miscellaneous freight at such a terminal Mr. Harding advocates the installation of me-

chanical appliances for hoisting and conveying the freight so that it can be transferred in the most direct way and with the least possible rehandling to any part of the terminal plant. It is pointed out, however, that the success of such a terminal depends not only upon the layout and equipment of the terminal itself, but also upon the design of the vessels and of their freight-handling machinery, and here the naval architect must be depended upon to cooperate with the terminal engineer.

Mr. Harding's recommendations call for at least two double winches for each hatchway on the ship and sufficient booms for burtoning the loads simultaneously either upon the shore or upon lighters. On the quay or piers the installation of traveling gantry jib cranes is recommended, one for each 100 feet of lineal frontage, spanning two or three railway tracks, which should be located between the shed and the quay wall. Within the shed overhead movable cross tracks are advocated, connecting with fixed side tracks, so as to assort and distribute the freight by a continuous succession of movements without rehandling and without using floor space, thus making available every cubic foot of space in the shed for the disposal of freight. This arrangement would afford a short path across the shed from a vessel on one side of the pier to another vessel on the other side, and the freight would be moved without congestion or delay by burtoning between the hooks of the gantry cranes, or ship's winches, and the hooks of the traveling hoists.

The above system may be said to apply in general to any marine terminal, although modifications and adaptations may be necessary in individual designs, depending upon the natural physical conditions of the terminal and the nature of the service for which it is intended.

Naval Preparedness

If the United States had had a large and efficient navy in 1897 there would have been no Spanish war, and if we had a large and efficient navy to-day there would be no ignoring of the rights of ordinary citizens to travel on the ocean, nor would there be the evident contempt for any expression of opinion on the part of our Government from certain belligerent sources. The attention of Congress has been called to this situation over and over again, but without avail. Naval bill after naval bill has aroused great opposition, resulting in compromises and, as a consequence, our naval strength has dropped from a commanding second position until it is now fourth or fifth among nations.

We need ships and we need trained men. Politicians and men high in office seem to think that talk will produce both of these, judging by the editorial comments and interviews appearing almost daily in the newspapers. Meanwhile, nothing is done. The Secretary of the Navy urges a naval reserve composed of men who have had naval training, but who have left the navy and returned to civil life. Such a reserve is a cheap imitation of the reserve that we need, for there can be no real preparedness simply by using only retired naval men.

What we need and must have, if preparedness is to be anything but talk, is a complete complement of men—masters, watch officers and seamen—who have had years of experience and who can be depended upon to navigate any vessels to which they are assigned. The great efficiency of the English navy when the present great war broke out was helped materially by the very capable naval reserves drawn from the merchant marine. These men must be trained along naval lines and, what is more important, they must be paid in order to secure their services in case of necessity.

No measure has ever been proposed that will aid naval preparedness and, at the same time, help build up the merchant marine in the foreign trade as well as the one referred to on page 145 of our issue of April last. The plan that we proposed was part of a bill to build up the American merchant marine in the foreign trade and, at the same time, to provide a special naval reserve that could be called upon instantly and that must of necessity be an efficient reserve, as all of the men would be in actual service on board merchant ships.

The first part of the bill is vital to the upbuilding of the merchant marine, in that the Government is the only source of financial support that can be looked to in these times for money to invest in ships. If the Government takes bonds in steamship companies up to a certain percentage of the value of the vessels, the security is of the very best. If interest in the merchant marine could be established by the Government encouraging the building and operating of ships in the foreign trade, the whole country would benefit, but the navy would benefit far more by the thorough training of a special naval reserve consisting of men who are doing duty every day on these merchant vessels.

A feature of the bill establishing this reserve requires that the men be citizens of the United States in order to benefit by the extra pay, and this benefit is extended not only to the masters, but watch officers and seamen. They are paid the difference in wages of the American rate and the rate paid on the competing ships flying other than American flags. Under this measure their wages are automatically maintained at the level of the American wage scale, and the men are all under obligation to serve the navy in case of need. It is estimated that $2,000,000 (£410,000) invested in this manner would support 32 merchant ships of 5,000 tons each for a year in the foreign trade. We would, at the same time, be building up our merchant marine for foreign trade on a substantial basis and be putting the navy into that condition for preparedness which it ought to be.

If Congress would take action along these lines and politicians and men high in office support such action, the question of naval preparedness would soon be effectively and efficiently solved. A splendid corps of men that would be invaluable in case of emergency could be trained in

this way for service in the navy, and the cost of this training would be scarcely half what it would cost to have the men trained on war vessels. Furthermore, the merchant marine in the foreign trade would be rapidly built up, so that the American flag in a very short period of time would be seen in all the great ports of the world.

The Task of Developing the American Merchant Marine

In a communication recently sent to the marine press, Mr. A. C. Holzapfel, who has long been identified with industries allied with shipbuilding and shipowning, analyzes the conditions which in his opinion are preventing the development of the American merchant marine in the foreign trade. He says, in part:

"That this country badly needs a mercantile marine for an international carrying trade, that it has the money to acquire such a marine, and that such a marine will have to be acquired during the next few years no sensible man can dispute. The two chief impedimenta which prevented American shipowners from developing international carrying trade in American bottoms were, until recent years, first, the impossibility of acquiring foreign-built ships and giving them the American flag, and second, the high import duties on steel (abolished several years ago) which enabled American steel manufacturers to charge higher prices for shipbuilding material than those ruling in foreign countries. Both of these disabilities have been removed and American steel is now sold in this country at prices 25 to 30 percent less than in Europe.

"There still remain, however, three difficulties which will have to be overcome before a general and unrestrained development of the building and owning of ocean steamers in this country can be accomplished. These are the following:

"First, financial shipping investments are in evil repute among American financiers owing to the gross over-capitalization of the International Mercantile Marine Company, which, however, is now being remedied by a drastic capital reorganization; also owing to the questionable financial system pursued by Mr. Morse when he combined the coasting fleets of this country.

"The second drawback is due to the insufficient insurance facilities for ships sailing under the American flag. The Government has already taken some steps to meet in some measure this difficulty which have resulted in considerable profit to the Government. Whether a government which wants to develop the shipping industry is wise in extracting large profits from such an industry during its development is obviously open to serious doubt. So far as I can ascertain, various comparatively small organizations dealing with ship insurance have done so to considerable profit; still, we are entirely without such an institution as Lloyds Underwriters of London, who transact probably 80 percent of the total sea insurance business of the world. It is surprising that this system of private underwriting has not been adopted to a substantial extent in the United States. Its adoption and the resultant facilities and economies for marine insurance would, no doubt, largely contribute to the development of an American merchant marine.

"The third disability is the fact that shipbuilding in the United States, in spite of the lower prices of steel, is still much more expensive than in Europe. The reason for this is the undoubted fact that shipbuilding is not so well organized in this country as in Europe, and that the overhead charges are enormous owing to the lack of specialization. The same builder who builds a battleship will also build a tug boat or a cargo tramp. There is no doubt that with the higher scale of wages obtaining in this country, specialization in shipbuilding is the only means of success. To a large extent shipbuilders on the lakes have specialized in certain types of vessels with very gratifying results. If the same thought and enterprise had been applied to the shipbuilding of the Atlantic coast, better results would have been obtained.

"It need hardly be discussed whether and to what extent Government help will be needed in the impending developments. There can be no doubt, however, that financial support from the public exchequer for a strictly limited period would help beginners over initial difficulties and would also help to attract capital to the shipbuilding and shipowning industries. Above all, let everyone realize that neither shipbuilding nor shipowning should be allowed to be exploited by the financial shark. The history of the two large shipowning combinations to which I have alluded, as well as of the shipbuilding trust founded by Mr. Charles M. Schwab, has proved conclusively that the shipping business cannot exist and compete against the rest of the world except on a strictly sound financial basis."

The premises stated by Mr. Holzapfel do not call for comment. The United States badly needs a merchant marine for its foreign trade, it has the money to develop one, and something will surely be done in that direction in the near future. Not all shipbuilders or shipowners, however, will agree with Mr. Holzapfel's conclusions as to the principal obstacles which are retarding this development.

Mr. Holzapfel ignores entirely the question of the cost of operation of steamships. The cost of building ships in the United States at the present time compares favorably with that in Europe; and as the volume of shipbuilding in this country increases, leading probably to greater specialization and standardization in individual shipyards, this condition will undoubtedly be further improved. The cost of running ships under the American flag, however, is higher than that of competing ships under foreign flags, and will remain so until the laws governing the navigation of American ships are modified or until government aid is extended in some form or other to overcome this barrier. Until this difficulty is overcome, the American merchant marine in over-seas trade will be, as it practically is today, non-existent.

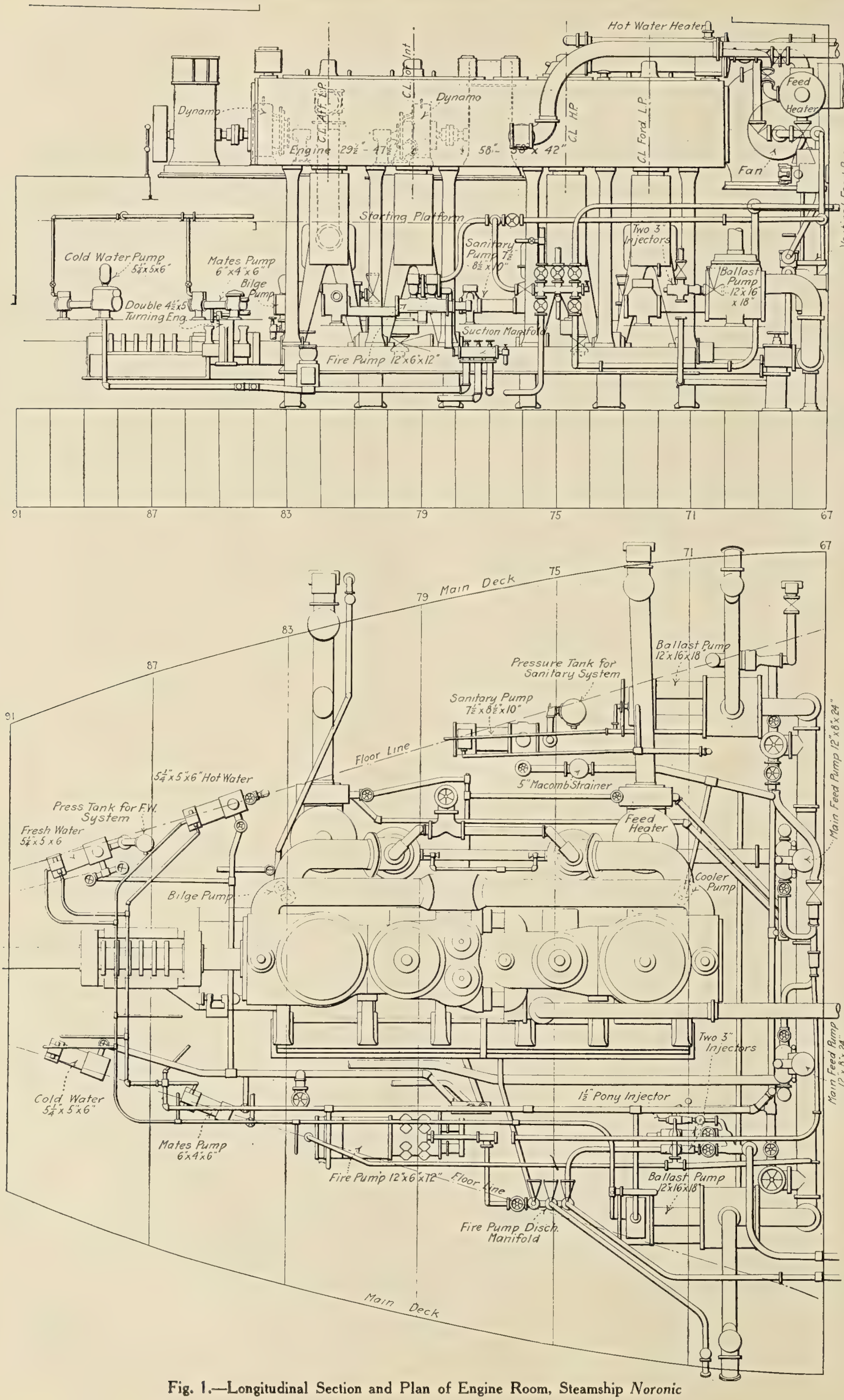

Fig. 1.—Longitudinal Section and Plan of Engine Room, Steamship *Noronic*

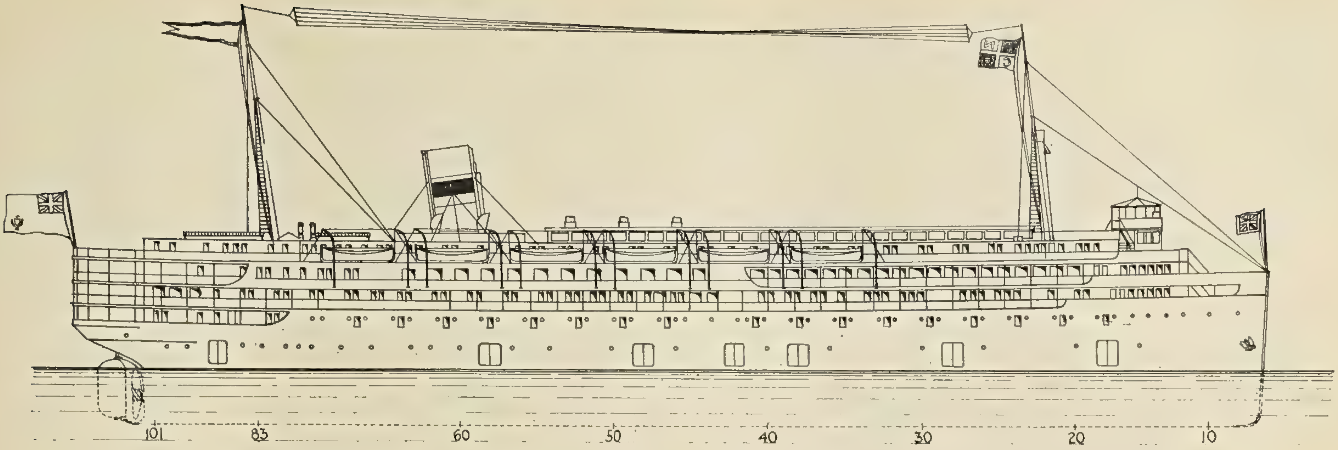

Fig. 2.—Steamship *Noronic*: Length overall, 385 Feet; Beam, 52 Feet; Depth, Molded, 28 Feet 9 Inches

Lake Passenger Steamer Noronic

New Vessel for the Northern Navigation Company, Ltd.—Description of Hull and Machinery—Trial Data

A notable addition was made during the past season to the large fleet of passenger vessels owned and operated by the Northern Navigation Company, Ltd., of Sarnia, Ont., by the completion of the passenger steamer *Noronic*. The hull and boilers were built by the Western Dry Dock & Shipbuilding Company, Ltd., Port Arthur, Ont., and the main engine by the Cleveland plant of the American Shipbuilding Company. The vessel operates on a six-day voyage between Sarnia, Ont., and Duluth, Minn., calling at the Soo and Port Arthur. Her principal dimensions are: Length overall, 385 feet; length between perpendiculars, 362 feet; breadth, molded, 52 feet; depth, molded, 28 feet 9 inches; indicated horsepower, 4,800; contract speed, 16.55 miles per hour,

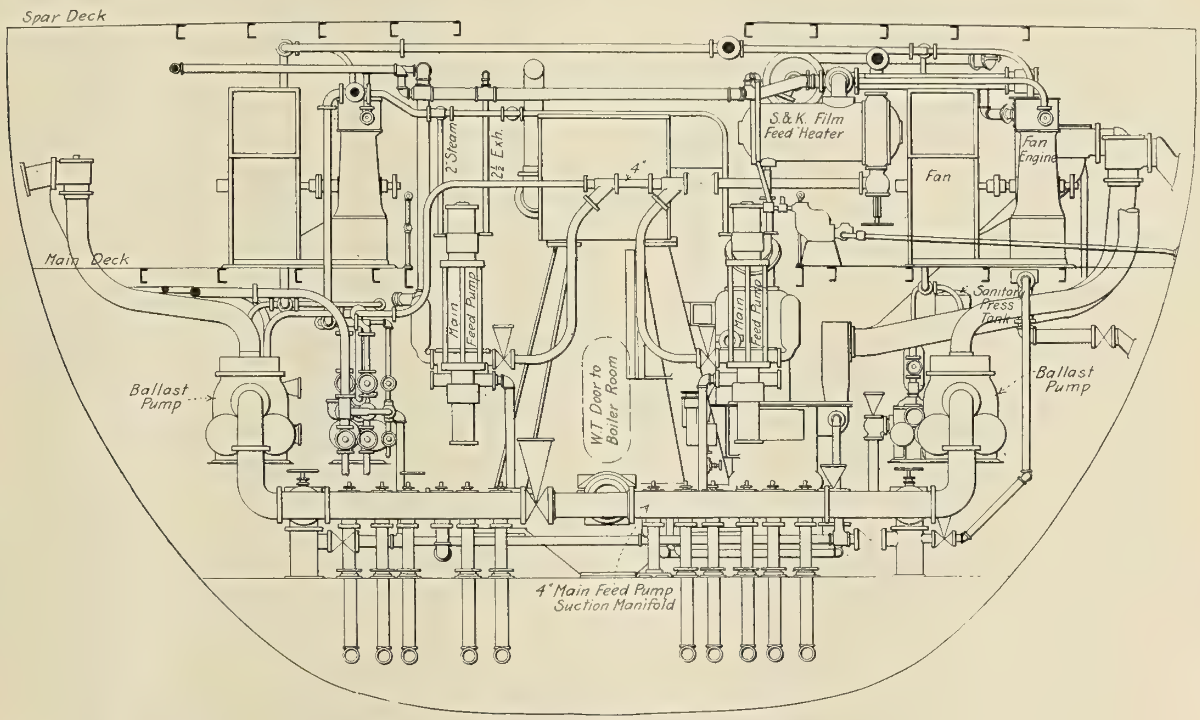

Fig. 3.—Cross Section Through Engine Room

The hull is built on the Isherwood system of longitudinal construction, a double bottom 4 feet 9 inches deep extending the full length of the ship. The hull is further subdivided by eight watertight bulkheads into nine compartments.

The *Noronic* is noteworthy for the luxurious passenger accommodations provided. There are 279 staterooms and parlors and her main dining room has a seating capacity for 286 persons. In the design of the interior decorations simplicity and goo taste prevail. The entrance hall on the main deck is finished in quartered oak; the spar deck is white enameled except in the social hall or lobby, which is finished in fumed oak. The promenade deck is of mahogany throughout. The dining room, galley, refrigerat-

ing and observation rooms are located on the observation deck. The observation room is 140 feet long, finished in oak and has a hard wood dancing floor. The dining room is 180 feet long and finished in mahogany. The boat deck is finished in oak and lighted by a large dome skylight. The various cabin decks and houses are all of steel.

The power plant is one of the most complete installations ever placed aboard a lake vessel and embraces every requirement to make up a modern high-class vessel. The engines and boilers are built under Lloyd's rules as well as Canadian Government rules.

Propelling Machinery

The main engine is a four-cylinder, triple expansion engine balanced on the Yarrow-Schlick-Tweedy system, developing 4,800 indicated horsepower. The cylinder dimensions are 29½, 47½, 58, 58 by 42 inches. In passing

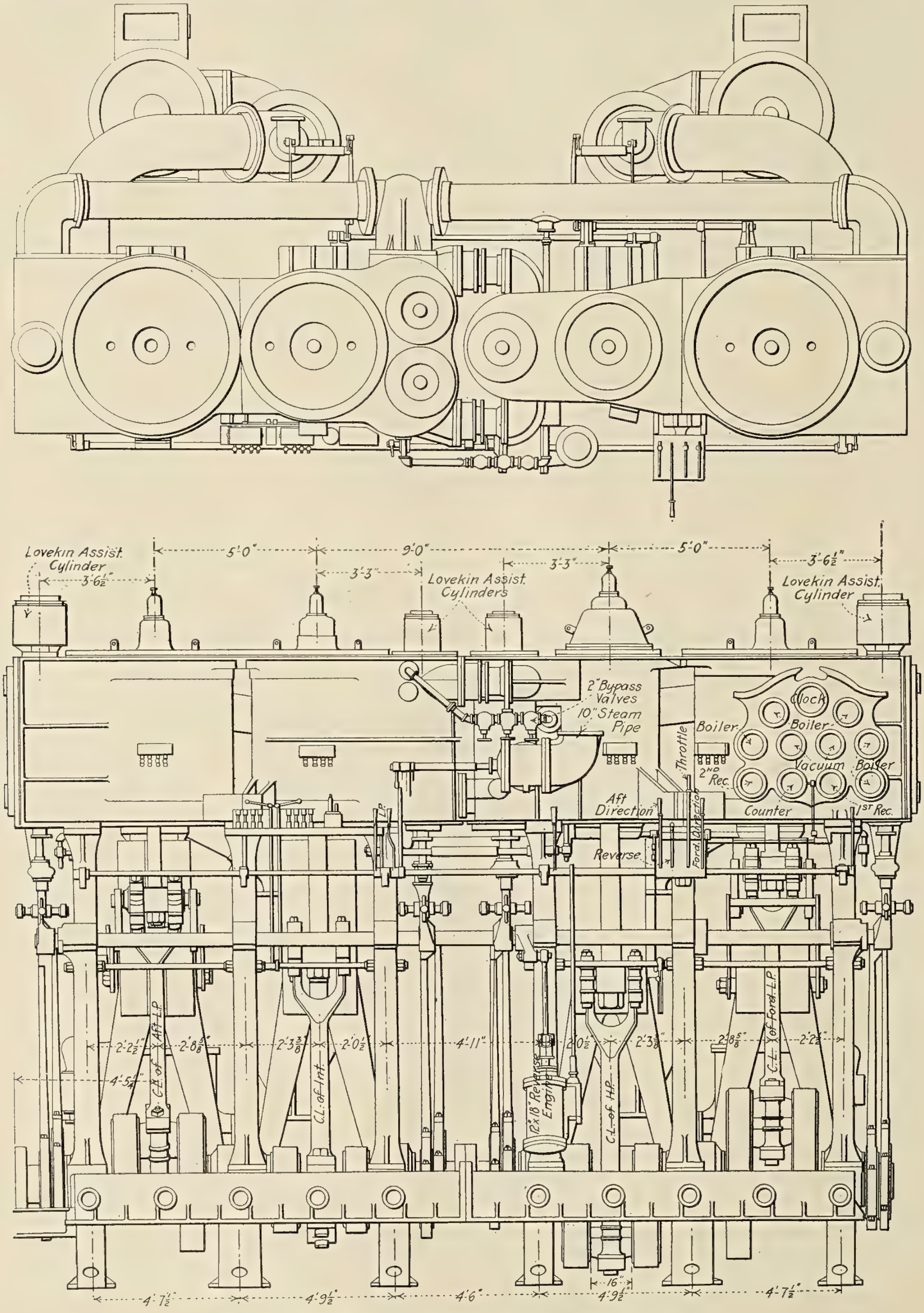

Fig. 4.—Main Engine, Designed to Develop 4,800 Indicated Horsepower

it may be noted there is a complete absence of vibration in the ship.

The cylinders are arranged from forward to aft as follows: low-pressure, high-pressure, intermediate- and low-pressure, supported by four back columns and six front columns. The high-pressure cylinder has one balanced piston valve and the intermediate two, while the low-pressure cylinders have double-ported slide valves and relief frames, all valves being driven by Stephenson link motion and also being fitted with especially designed Lovekin patent assistant cylinders.

The back columns are of the inverted Y type, box section, and carry the guides and separate water backs. The front columns are of the I section, well ribbed and tied together. The bed plate is of the girder section, built in two sections and having six main bearings with removable cast steel shells lined with Phoenix metal. The thrust block is bolted to the bed plate and has bearings at each end and six horseshoe collars with liberal wearing surfaces. The thrust block, in addition to the usual dope cup lubrication, has a forced oiling system.

All pistons are cast steel, cone shaped, the high-pressure and intermediate having solid bull rings without piston rings, while the low-pressure pistons have two spring rings each. The piston rods are of steel, taper fitted to the pistons and crossheads and secured with nuts. The high-pressure and intermediate-pressure rods are 6½ inches diameter and the low-pressure rods are 5½ inches diameter. The crossheads are of the block type bolted to cast steel shoes which have slippers of brass with M & M metal. The connecting rods are mild steel forgings with forked top ends and adjustable brasses and tee-ended bottoms with cast steel boxes lined with Phoenix metal.

The propeller is sectional, 16 feet 6 inches diameter and 17 feet pitch, with cast iron hub and four cast steel blades with machined surfaces, all balanced in the shop. The expanded area is 87.22 square feet.

A departure from usual designs is shown in the air pumps, of which there are two, instead of the customary one, driven from the low-pressure crossheads. They are the Edwards patent type, 33 inches diameter by 15 inches

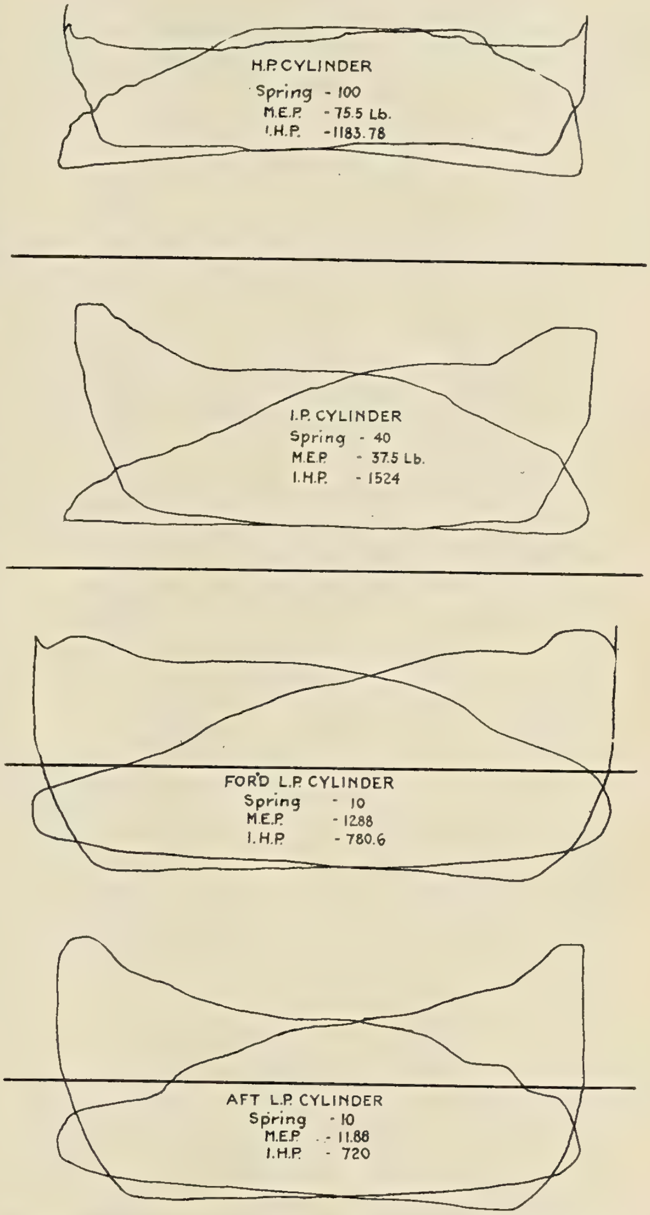

Fig. 6.—Indicator Cards Taken on Trial Trip. Total I. H. P., 4,209; Boiler Pressure, 195 Pounds; Vacuum, 24 Inches; R. P. M., 108

stroke, each working in connection with its own jet condenser. There are also fitted one bilge and one cooler pump, driven from each low-pressure engine.

The steam reversing engine is 12 inches diameter by 18 inches stroke and the steam turning engine is a double 4½-inch by 5-inch engine.

The engine is handled from a working grating at about the height of the reverse shaft, so that at all times the engineer can observe the working of his engine both below and above him, and has within his sight all gages and controls for pumps, etc.

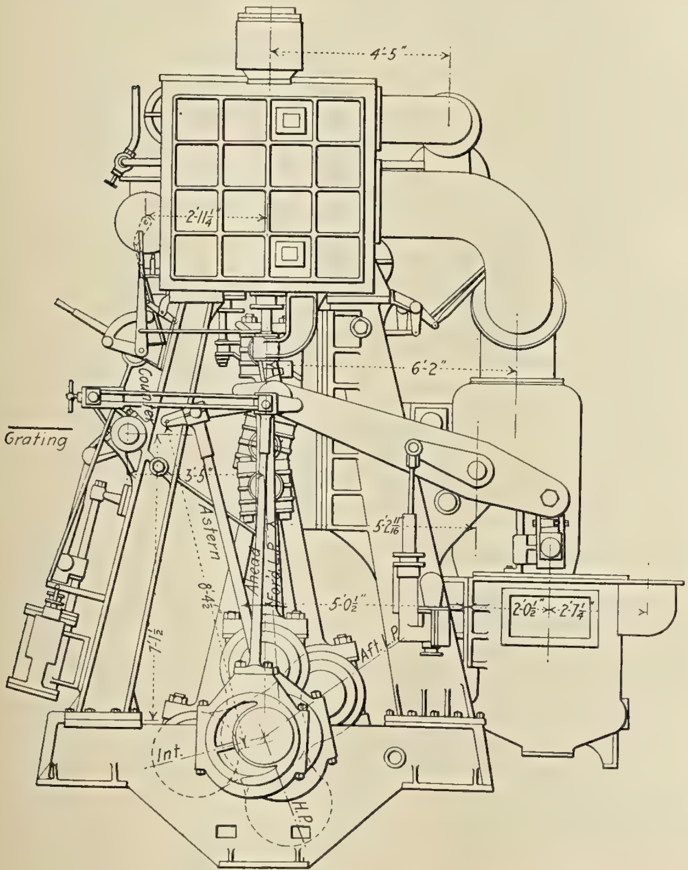

Fig. 5.—End View of Main Engine

Boilers

The steam generating plant consists of four main Scotch boilers and one donkey Scotch boiler. The main boilers

are set in pairs with fire-rooms fore and aft. They are 15 feet 6 inches inside diameter, 11 feet long, built for 200 pounds pressure. Each boiler has three 48-inch diameter Morison furnaces.

An interesting feature of these boilers is the shell plate which is made in two plates only without the usual center girth seam, the length of the plate being 124¾ inches and the thickness 1 19/32 inches.

The donkey boiler is installed immediately forward of the main boilers and is 12 feet 6 inches diameter by 11 feet long and has two 48-inch diameter Morison furnaces. It also is similar in design to the main boilers, and is connected to the auxiliary steam pipes for use in port and also to the main steam pipe for emergency use. All boilers are connected to a common breeching and one smokestack, which is double, elliptical in form, the diameters being 13 feet 6 inches and 10 feet. The top of the stack rises 82 feet above the grates.

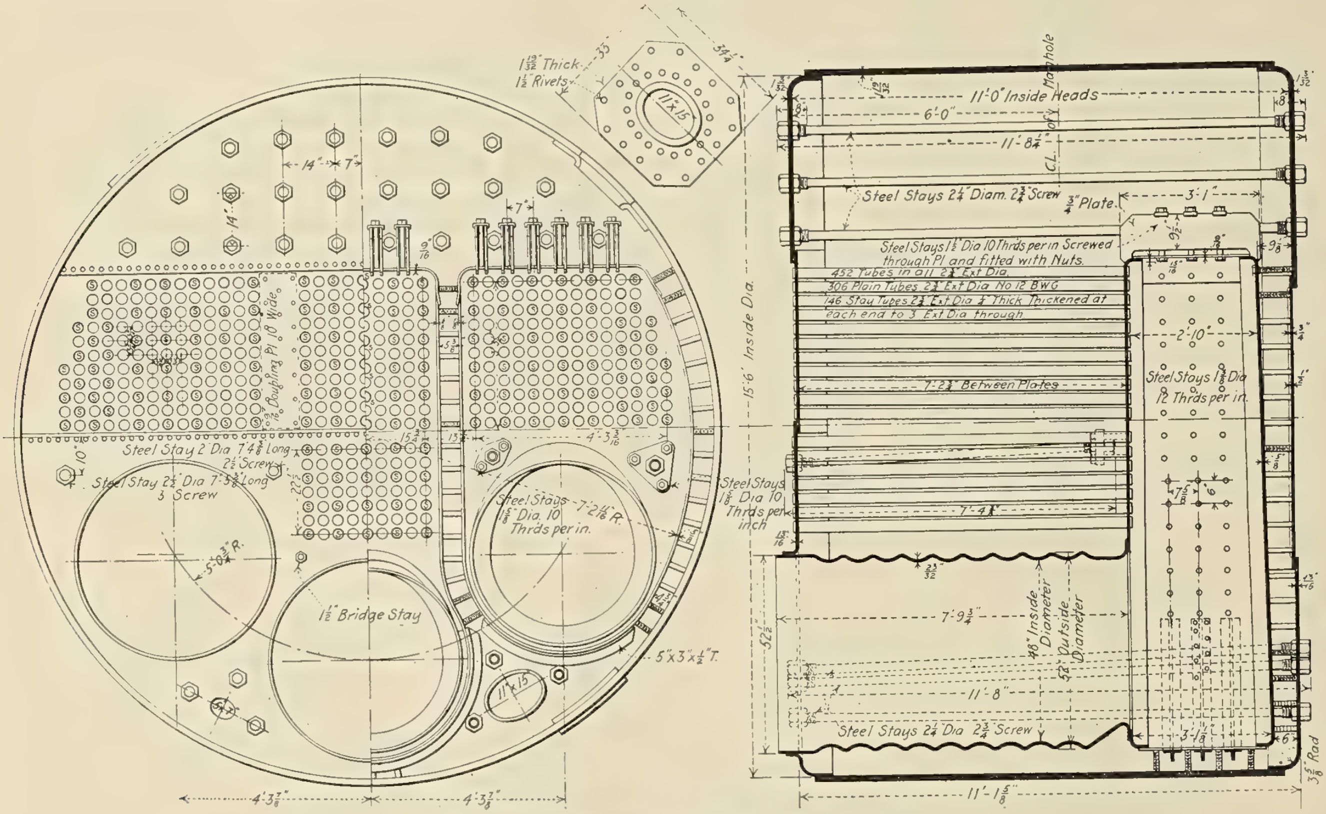

Fig. 7.—General Plans of One of the Main Boilers

Auxiliary Machinery

The main feed pumps are in duplicate, of the Weir vertical type installed on the engine room bulkhead immediately forward of the engine. They are of the piston pattern 12 inches by 8 inches by 24 inches single type, one pump being capable of feeding all five boilers while the other is held for emergencies. Particular care has been used in the feed lines in eliminating all right angle turns, there being no sharp angles in the pipe. The water is delivered to a horizontal Schutte & Koerting film feed heater with a capacity of 75,000 pounds of water at 210 degrees. There are also two 3-inch Metropolitan injectors for the main boilers and one 1½-inch injector for the donkey boiler. In addition to the above means of feeding boilers, the duplex fire pump, 12 inches by 6 inches by 12 inches, is also connected to the feed water heater. This pump also discharges to the fire line, pony feeds, condensers, ash guns and overboard for pumping the engine room bilges.

The sanitary pump is a duplex piston pattern 7½ inches by 8½ inches by 10 inches, connected to the sea and discharging to the sanitary system through a pressure regulating tank. There are three pumps installed for the water supply system, one for hot water, one for cold water and one for drinking water and kitchen service, all being duplex piston pumps 5¼ inches by 5 inches by 6 inches. The hot water pump draws from the sea and discharges to a water heater in which exhaust steam is circulated for heating the water and maintaining it at the required temperature. The cold water pump also has sea suction and discharges to fresh water tanks built into the ship abreast of the forward boiler room. These tanks are filled with pure water from Lake Superior only. From these tanks the fresh water pump takes its supply and discharges through a pressure tank to the fresh water system. All staterooms have running hot and cold water supplied by these pumps. Especial care has been taken with these systems to insure an absolute pure supply of water, and these pumps have no other connections which might contaminate the water.

The ballast pumps are two in number, duplex piston pattern 12 inches by 16 inches by 18 inches, each connected with a common manifold in the engine room through 12-inch suction pipes. From this manifold is led a 6-inch pipe to each ballast tank in the ship. The entire system of tanks contains 1,574 tons of water.

In addition to the foregoing pumps there is also installed a duplex piston pump 6 inches by 4 inches by 6 inches for mates' service, which is connected to both the fire line and the fire pump manifold. All these pumps are in the lower engine room and are of the Warren Pump Company make.

On the main deck in the engine room are two No. 8

Sirocco fans, direct connected to 6-inch by 6-inch vertical engines for the Howden forced draft system. These fans have a capacity of 35,000 cubic feet of air per minute each. On this deck are also two Crocker Wheeler 50 kilowatt dynamos, direct connected to 9-inch by 8-inch American Blower Company engines and a complete switchboard controlling all circuits throughout the ship.

On the port side of the main deck is installed a Kroeschell refrigerating plant of 12 tons daily capacity.

One of the great features on this boat is the arrangement of steering gear. There are two engines installed of the direct acting type, both geared to the same quadrant. They are 9-inch by 9-inch American Ship Building Company engines, and are of the very latest design. One engine is in gear at all times, while the other is ready for use in emergency, and either engine may be thrown in or out of gear from the pilot house by means of a small steam cylinder geared to clutches on the engine pinions. The steam controlling valves of both the engines and clutch-shifting cylinder are operated by shafting from the pilot house, thus giving the wheelsman absolute control at all times of his steering gear.

Deck Machinery

The windlass is the American Ship Building Company 10-inch by 10-inch spur-geared type, with wildcats for 2⅛-inch stud link anchor chain. There are also fitted to the windlass two line spools for wire line which are used for mooring the bow end of the vessel if so required.

Other mooring gear is supplied by two double cylinder 8-inch by 10-inch American Ship Building Company deck engines, one fitted about amidship for mooring to either side, and the other fitted aft on the fantail.

The cargo-handling apparatus is interesting, being of the well-known type adapted to the lake trade. A 12-inch by 12-inch double steam engine is placed at the after end of the cargo hold and connected to a 3 7/16-inch shaft running to the forward end of the hold. On this shaft at each cargo hatch and gangway are two friction wheels which engage with drums 10 inches diameter and 3 feet 3 inches long, over which the hoisting tackle runs. The shaft is placed under the deck above the cargo hatches and is started when the cargo is to be loaded or unloaded, and runs continuously in the same direction, hoisting being accomplished by engaging one drum which revolves in the necessary direction and loading by engaging the adjacent drum.

For removing ashes from the fire room, four 7-inch hydraulic ash guns are fitted, discharging above the load waterline, each with large receiving hoppers with water-tight covers.

On all the machinery throughout the vessel are fitted the necessary railings, gratings, safety guards, etc., and all modern devices found in an up-to-date ship are here serving the purposes for which they were intended. Besides this, the comfort and well-being of the crew have been attended to in the most approved manner. The accompanying plans show clearly the installation of the power plant.

Trial Data

The contract requirements specified by the owners called for an average speed of 16.65 miles per hour for a continuous run of six hours' duration with all usual auxiliaries running and with 1,500 tons of freight on board. The trial was to take place on Lake Huron on May 6, the course being laid from Thunder Bay Island, Mich., to Port Sanilac, Mich. Exceptionally rough and foggy weather, however, made it advisable to carry out the trials over a shorter course and in shallow water between Harbor Beach and Port Sanilac, a distance of 29 miles, going over the course until the six-hour run had been completed. During the trial two feed pumps, two blowers, two electric light engines, the hot and cold water and sanitary pumps, the steering engine and the ash gun pumps were running. A cargo of 1,696 tons was on board and the run lasted for six hours and thirty-five minutes. The following are the principal data from this run:

Displacement, gross tons	5,412
Area immersed midship section	776.5
Wetted surface, square feet	21,890
Draft, forward	11 feet 3 inches
Draft, aft	18 feet 1 inch
Draft, mean	14 feet 8 inches
Speed, miles per hour, average *	17.43
Slip of propeller, average †	11.6 percent
Steam pressure, average	192.71
First receiver pressure, average	73.05
Second receiver pressure, average	15.49
Vacuum, inches	23.93
Revolutions per minute, average	106.8
Indicated horsepower, high-pressure cylinder, average	1,169.6
Indicated horsepower, intermediate-pressure cylinder, average	1,505.7
Indicated horsepower, low-pressure cylinder aft, average	711.5
Indicated horsepower, low-pressure cylinder forward, average	771.2
Indicated horsepower, total, average	4,158
Mean effective pressure referred to low-pressure cylinder, pounds	34.2
Indicated horsepower per square foot grate	13.5
Square feet of heating surface per indicated horsepower	3.16
Temperature of injection water, approximate	40 degrees
Temperature of hotwell water, approximate	110 degrees
Temperature of feed from heater, approximate	200 degrees
Draft, inches of water at fans	3.73
Quality of coal	fair

* 17.71 miles per hour for four hours.

† Slip figured for speed of 17.71 miles per hour and 106.8 revolutions per minute.

The vessel ran in shallow water throughout the test and heavy winds with squalls prevailed, which was very disadvantageous to a speed test. It is estimated that with a proper depth of water and good weather conditions, the vessel can readily make a speed of 18 miles per hour or better.

The *Noronic* made her first trip of the season, leaving Cleveland, Ohio, on June 18, for Duluth and return.

First Year of the Panama Canal.—From August 15, 1914, to July 1, 1915, which constitutes the first fiscal year of the operation of the Panama Canal, a total of 1,088 vessels passed through the Canal, carrying an aggregate of 4,969,792 cargo tons. Five hundred and thirty of these vessels passed through the Canal from the Pacific to the Atlantic, and 558 went in the opposite direction. The receipts for the first year, August 15, 1914, to August 15, 1915, from tolls was $5,216,149 (£1,070,000), representing the passage through the Canal of 1,317 ocean-going vessels of a gross tonnage of 6,494,673 and a net tonnage of 4,596,644. That the traffic through the Canal is rapidly growing is shown by the fact that during July about 65 percent more vessels passed through the Canal than the average for the preceding months. The cargo carried through the canal during the month totaled 705,469 tons, which exceeds the shipments during any previous month. The tolls collected during the month amounted to $573,366 (£118,000).

New United States Battleships.—The plans for the two new battleships for the United States navy authorized by the last Congress were approved by the Secretary of the Navy on September 10. These ships will be 624 feet long over all, 600 feet long between perpendiculars, 97 feet 8 inches extreme beam, 30 feet mean draft, 20½ knots speed and about 32,000 tons displacement. The cost for each ship, exclusive of armor and armament, amounts to $7,800,000 (£1,600,000). The main battery of each vessel will consist of twelve 14-inch guns, and the secondary battery of twenty-two 5-inch rapid-fire guns and four submerged torpedo tubes. Bids for the construction of these vessels will be opened on November 17.

Steamship Design

A Method of Determining the Principal Dimensions

BY H. A. EVERETT *

In the design of a merchant ship there are usually two or three items of prime importance, and the problem, in brief, consists of building the smallest vessel necessary to give these items. For example, in general, the amount of deadweight carry capacity, the speed and steaming radius are the items of first importance, for the first is the cause of being, so to speak, of the vessel and the others affect the carrying power throughout service.

These factors—carrying capacity, speed and fuel capacity—are usually stipulated by the owners, and from economic reasons purely; it is also common for owners to stipulate maximum draft, not from economic reasons, however, but from the nature of the harbors and docks to which the ship must have access when in service. The designer, therefore, is usually approached with the request to design a ship to carry so much cargo, to be able to go at a certain speed, and be able to make voyages to ports that are at so many knots distant.

In addition, it is stated that the vessel ought not to draw more water than a certain maximum draft, and in most vessels that are of good size this draft is accepted at once for the approximate draft of the ship, as in general, for the same carrying capacity and beam, the deeper draft ship will be cheaper both to build and maintain in service. This simplifies the problem materially, as it approximately fixes one dimension—namely, the draft.

In deciding upon dimensions which will be suitable for desired conditions there are several methods that are in common use. One consists in assuming a set of dimensions, sketching lines in accordance therewith, and on these estimating the weights of the various parts that make the complete vessel; if the displacement is not enough or too much to carry the estimated weights plus the cargo, the process is repeated. This method of trial and error, while perhaps the most common for the experienced naval architect, depends so entirely upon the data and experience of the designer that it is of but slight value in the hands of one of little experience.

Other methods rely upon some empirical formulæ to give the summation of weights which is to be balanced by the displacement, and in this general class is the one which will be used here. It is based upon the method outlined by Naval Constructor Woodward,† which has for its underlying principle the fact that the various coefficients of fineness of the boat, as block coefficient, etc., are functions of linear dimensions and that the stability of the ship is measured by the metacentric height which can be expressed as a function of the beam. All new designs must be governed by information regarding previous ships, as the combinations of length, beam and draft to give a certain displacement are infinite; and also any result which is arrived at as a first solution must be considered purely tentative, and should be but the basis of later refinement.

Consider now an actual case, the design of a vessel to fulfill the following requirements:

1—The hull shall be constructed of a certain type and material, the form being defined by the assumption of coefficients of fineness.

2—The vessel shall have machinery capable of giving her a speed on trial of S knots under customary trial conditions of fair weather, clean bottom, good coal, etc.

3—The vessel shall carry sufficient normal coal supply to have a radius of action of K knots at the above-named speed.

4—The vessel shall have capacity for carrying a certain deadweight composed of stores, fresh water and cargo, and also a certain hull outfit of a given weight, the above all totaling to the weight W.

5—The vessel shall have a certain metacentric height when at load draft.

The above requirements represent fairly the principal points to be considered in obtaining the first approximation to the principal dimensions.

The dimensions which are to be determined are:

L = the length of the immersed body in feet,
b = the maximum breadth of the immersed body in feet,
d = the mean draft of the immersed body in feet.

The mean draft considered is that of the immersed body proper, exclusive of any projecting bar or other keel.

The nature of the form of the immersed body of the vessel is defined by assuming the values of coefficients of fineness derived from those of a satisfactory vessel.

The coefficients of fineness used are:

α, *the block coefficient of fineness,* or ratio of volume of the normal displacement V to that of the circumscribed parallelopiped.

$$\alpha = \frac{V}{L\,b\,d}, \tag{1}$$

V being given in cubic feet.

β, *the cylindrical coefficient of fineness,* or ratio of volume of the normal displacement to that of the circumscribed cylinder.

$$\beta = \frac{V}{L\,M}, \tag{2}$$

M being the area of the immersed midship-section in square feet.

γ, *the coefficient of fineness of load waterline,* or ratio of area of load waterline to that of its circumscribed rectangle,

$$\gamma = \frac{A}{L\,b}. \tag{3}$$

A being the area of the load waterline in feet.

The first step in the determination of the principal dimensions is to establish two equations involving them, which may be called respectively:

(I) The equation of weights.

(II) The equation of stability.

Let us first consider Equation II, the equation of stability; it is necessary to deduce a relation between the general dimensions of the design which will fulfill the requirement that the vessel shall have a certain metacentric height.

The position of the center of gravity of the ship should

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† Proceedings of the Society of Naval Architects and Marine Engineers, Vol. I.

be obtained by direct comparison with some other similar vessel, as it is treated as a function of the draft and is subject to considerable variation with different types of vessels.

It is assumed at a point G (Fig. 1) situated at a distance from the waterline

$$G\,O = v\,d. \qquad (4)$$

v being a percentage depending upon the type of vessel. To obtain the position of the metacenter M it is necessary to express the distance $B\,O$ of the center of buoyancy from the load waterline, and the metacentric radius $B\,M$, in

It is desirable here to consider the comparative accuracy of the two formulæ that form the basis of the equation of stability.

The expression for the vertical position of the center of buoyancy is usually correct to one-half of one percent of the mean draft. That of the metacentric radius $B\,M$ is by no means as accurate, and the expression for $G\,O$, or the location of the center of gravity of the hull, is the least satisfactory, as the variation with different types of vessels is large. With information concerning similar ships, however, the formula gives good results, and has

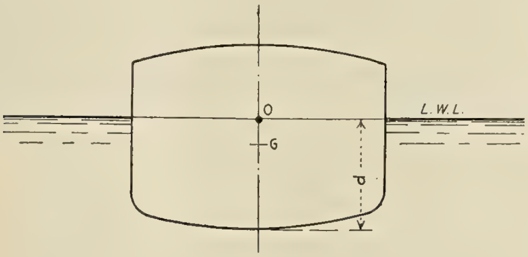

Fig. 1

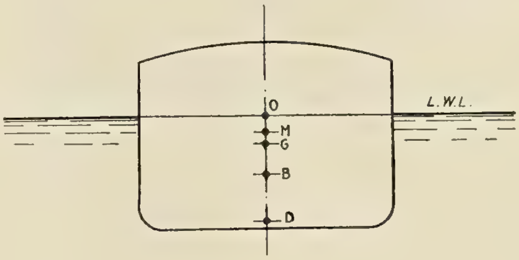

Fig. 2

terms of the principal dimensions and the coefficients of fineness of the design. The following formulæ, due to M. Normand, may be used for the purpose:

$$B\,O = \frac{d}{6} + \frac{\text{Vol.}}{3\,\text{Area}\,L.\,W.\,L.},$$

but as

$$\frac{\text{Vol.}}{\text{Area}\,L.\,W.\,L.} = \frac{\alpha\,L\,b\,d}{\gamma\,L\,b},$$

where

$$\gamma = \text{coefficient of fineness of } L.\,W.\,L.$$

we have

$$B\,O = \frac{d}{3}\left(0.5 + \frac{\alpha}{\gamma}\right) \qquad (5)$$

The formula for metacentric radius is

$$B\,M = \left[0.008 + 0.0745\left(\frac{\text{Area}\,L.\,W.\,L.}{L\,b}\right)^2\right]\frac{b^3\,L}{\text{Vol.}},$$

and as

$$S = \gamma\,L\,b \text{ and Vol.} = \alpha\,L\,b\,d,$$

we have

$$B\,M = \left[0.008 + 0.0745\,\gamma^2\right]\frac{b^2}{\alpha\,d}. \qquad (6)$$

The equation of stability which expresses the requirement that the vessel shall have a certain metacentric height ($G\,M$) (Fig. 2) may, therefore, be written

$$GM = BM - (BO - GO), \qquad (B)$$

and substituting in this the values derived above, we get

$$GM = (.008 + .0745\,\gamma^2)\,\frac{b^2}{\alpha\,d} - \left[\frac{d}{3}\left(\frac{1}{2} + \frac{\alpha}{\gamma}\right) - vd\right] \qquad (7)$$

solving for b in terms of d

$$b = \sqrt{\frac{\dfrac{\alpha\,d^2}{3}\left(\dfrac{1}{2} + \dfrac{\alpha}{\gamma} - 3\,v\right) + \alpha\,d \times GM}{.008 + .0745\,\gamma^2}} \qquad (8)$$

the merit of being logical and of taking cognizance of the question of stability at the beginning of the design, which is not true of some methods of determining the important dimension of beam.

Consider now the equation of weights (I):

Let D = normal displacement of the ship in tons,
h = weight of hull and fittings in tons,
m = weight of machinery in tons,
n = weight of normal coal supply in tons,
W = weight of cargo, fresh water, stores and hull outfit in tons.

Then, evidently,

$$D = h + m + n + W. \qquad (9)$$

Consider the right-hand member of this equation in detail.

Weight of Hull

The weight of hull and fittings may be considered as a certain percentage of the normal displacement. As with many of the other percentages which are hereafter assumed, it presupposes at least an approximate knowledge of the very dimensions which are to be determined, and of the general method of construction and material to be used in building. Calling δ the value of this percentage, the weight of hull and fittings is given by

$$h = \delta \times D. \qquad (10)$$

Weight of Machinery

To estimate the weight of machinery it is necessary to first make an approximation to the indicated horsepower P required to propel the vessel at the speed S. To do so we use the Admiralty displacement coefficient,

$$B = \frac{D^{2/3} \times S^3}{P}. \qquad (11)$$

B is the Admiralty coefficient, a coefficient of performance based on the trials of ships of similar form. It varies with the dimensions, form and speed adopted, in general from about 250 to 300.

If p is taken as the number of horsepower per ton of

machinery for the type of engines and boilers which it is intended to employ, the total weight of machinery m is evidently by (11)

$$m = \frac{P}{p} = \frac{D^{2/3} \times S^3}{p \times B}. \qquad (12)$$

Weight of Coal

The normal coal supply (n) required to give the vessel a steaming radius of K knots at the speed S may be considered as composed of the coal used in the actual propulsion of the ship, and that used in the various auxiliary services of heating, electric lighting, galley, distilling, steering gear, ventilating blowers, etc. The consumption of coal for the auxiliaries may be assumed to be approximately independent of the speed and equal to g pounds per hour. Designate by c the coal consumption of main engines with dependent auxiliaries in pounds per indicated horsepower per hour at the speed S.

The coal used in propelling vessel in tons per hour is, therefore,

$$\frac{c}{2{,}240} \times P = \frac{c \times D^{2/3} \times S^3}{2{,}240\, B_2}. \qquad (13)$$

Multiply this by $\frac{K}{S}$ to have total amount for the distance K, since the number of hours' steaming will be $K \div S$.

The coal used in auxiliary steam services is

$$\frac{g}{2{,}240} \times \frac{K}{S}. \qquad (14)$$

Therefore, the normal coal supply is expressed by

$$n = \frac{c \times D^{2/3} \times S^3 \times K}{2{,}240\, B \times S} + \frac{g\,K}{2{,}240\, S}. \qquad (15)$$

While the hull weight can be fairly satisfactorily represented as a function of the displacement, the hull outfit is, practically, independent of size, being more dependent upon the type of ship and service it is to engage in. In this should be included such items as carpenter and joiner work, wood decks, lighting, ventilation fittings, rigging and spars, deck machinery and installations for heating, ventilating, refrigeration and generation of electricity, including the auxiliary boiler. Thus it can be readily seen that a close estimate can better be made by *estimating outright* the hull outfit, knowing the conditions the ship is to work under, than to attempt to represent it as a function of hull displacement. It can then be added to the required cargo and treated as a fixed weight.

Now, the displacement must equal the sum of the various weights, so that the equation of weights is

$$D = h + m + n + W,$$

which may, therefore, be rewritten as follows:

$$\underset{\text{(hull)}}{D = \delta\, D} + \underset{\text{(machinery)}}{\frac{D^{2/3} S^3}{p\,B}} + \underset{\text{(normal coal)}}{\left[\frac{c\,D^{2/3} S^3 K}{2{,}240\,B\,S} + \frac{g\,K}{2{,}240\,S}\right]} + \underset{\text{(fixed wts.)}}{W} \qquad (16)$$

or arranging the terms of the equation according to powers of D,

$$D\,(1 - \delta) = D^{2/3}\left(\frac{S^3}{p\,B} + \frac{c\,S^2 K}{2{,}240\,B}\right) + \frac{g\,K}{2{,}240\,S} + W \qquad (17)$$

But 35 cubic feet of sea-water weigh, approximately, one ton, or $35\,D = V$, and, substituting in (17) the value of D.

$$D = \frac{V}{35} = \frac{\alpha\, L\, b\, d}{35},$$

and arranging the terms according to powers of L,

$$L\,b\,d\,(1 - \delta) - L^{2/3}\,(b\,d)^{2/3} \left(\frac{35}{\alpha}\right)^{1/3} \left(\frac{S^3}{p\,B} + \frac{c\,S^2 K}{2{,}240\,B}\right) - \frac{35}{\alpha}\left(\frac{g\,K}{2{,}240\,S} + W\right) = 0 \qquad (18)$$

This may be considered an equation of the form

$$L + L^{2/3} + y = 0 \qquad (19)$$

$$\text{where } X = -\frac{(db)^{2/3}\left(\frac{35}{\alpha}\right)^{1/3}\left(\frac{S^3}{p\,B} + \frac{c\,S^2 K}{2{,}240\,B}\right)}{(1 - \delta)\,bd} \qquad (20)$$

$$y = -\frac{\frac{35}{\alpha}\left(\frac{g\,K}{2{,}240\,S} + W\right)}{(1 - \delta)\,bd} \qquad (21)$$

The solution of the equation (15) is given by

$$L = \left[-\frac{x}{3} + \sqrt[3]{-\frac{y}{2} - \frac{x^3}{27} + \sqrt{\frac{yx^3}{27} + \frac{y^2}{4}}} + \sqrt[3]{-\frac{y}{2} - \frac{x^3}{27} - \sqrt{\frac{yx^3}{27} + \frac{y^2}{4}}}\,\right]^3 \qquad (A)$$

in which the value of L is expressed directly as a function of b and d; this equation being obtained, as has been seen, by stating analytically the fact that the volume of water which the ship displaces has a weight equal to that of the hull and its contents.

The solution for length from formula A is entirely valueless unless seven-place logarithms are used and accurate interpolation made, as we are dealing in the last term with the very small difference of two large quantities. There is, however, a rearrangement possible which will permit the use of five-place logarithms as follows:

The second term is rearranged and the difference is expressed so as not to involve a direct subtraction and a value for the entire cube root expression obtained. The second cube root is of the form

$$\sqrt[3]{A - \sqrt{B}} \text{ if we let } A^2 - B = \Delta$$

then

$$(A - \sqrt{B})\,(A + \sqrt{B}) = \Delta$$

$$(1) \text{ and } (A - \sqrt{B})^{1/3} = \left(\frac{\Delta}{A + \sqrt{B}}\right)^{1/3}$$

In the right-hand member there is a sum of two quantities instead of a difference. The value of Δ in terms of x and y is (from equation A)

$$\Delta = A^2 - B = \left(-\frac{y}{2} - \frac{x^3}{27}\right)^2 - \left(\frac{x^3 y}{27} + \frac{y^2}{4}\right)$$

$$= \frac{y^2}{4} + \frac{yx^3}{27} + \frac{x^6}{27^2} - \frac{x^3 y}{27} - \frac{y^2}{4}$$

therefore

$$\Delta = \frac{x^6}{27^2}$$

inserting this in (1) and substituting in A the following is obtained:

$$L = \left[-\frac{x}{3} + \sqrt[3]{-\frac{y}{2} - \frac{x^3}{27} + \sqrt{\frac{yx^3}{27} + \frac{y^2}{4}}} + \sqrt[3]{\frac{\dfrac{x^6}{729}}{\sqrt{-\dfrac{y}{2} - \dfrac{x^3}{27} + \sqrt{\dfrac{yx^3}{27} + \dfrac{y^2}{4}}}}} \right]$$

Five-place logarithms will be sufficiently accurate for the solution of this expression.

If preferred, the cubic equation (18) or (A) may be solved graphically by selecting several trial values for L, plotting the results and interpolating for the value, which satisfies the equation.

The resultant equations for length (A) and stability (B) express the relations that must exist between the three unknown quantities L, b and d, if the equations of weight and stability are to be fulfilled. There are, therefore, an unlimited number of possible solutions, and, in order to determine a particular solution, some further requirement must be adopted.

In the case in hand it will be the assumption of a limiting draft. This requirement is in the nature of a limit which must not be surpassed, but which need not necessarily be attained; even in the general case where no limit is put upon any particular dimension by the requirements of the future service of the vessel. Limits are implicitly given by the fact that the various coefficients of weight of hull, machinery, coal consumption, propulsion, utilization, etc., which have been assumed in the formation of the two equations of condition, can only be considered as constant for moderate variations in the dimensions. It is, therefore, necessary to observe the influence of small changes in the principal dimensions.

For a merchant ship draft is the dimension in general which is defined between the narrowest limits, so that in the solution of the problem it will be well to assume several drafts and solve for the other dimensions. Probably the methods can best be followed by a concrete illustration, for which the following will suffice.

Problem in Ship Design

To obtain the dimensions of a vessel to fulfill the following conditions:

1—To carry 9,163 tons of cargo, fresh water and stores and an outfit of 963 tons.
2—To have a mean draft of not more than 28 feet.
3—To have sufficient power to make a speed of 13 knots.
4—To be able to steam 3,400 knots at a speed of 13 knots.
5—To have a metacentric height (GM) of 2 feet.
6—The vessel is to be of the double-bottom, shelter-deck type, built to the requirement of Lloyd's.
7—The cargo to be general merchandise.

In addition to the above data, which are determined from commercial and route conditions, it is necessary to assign factors of fineness, power and weight; and while the choice of proper values of these presupposes to a certain extent knowledge of the final dimensions, yet within narrow limits proper values can be assigned from the naval architect's experience with ships of a similar nature built for similar trade and conditions. Accept, then, the following constants as the data at hand:

α—Block coefficient	.778
γ—Load waterline coefficient	.879
β—Prismatic coefficient	.804
α/β—Mid-section coefficient	.968

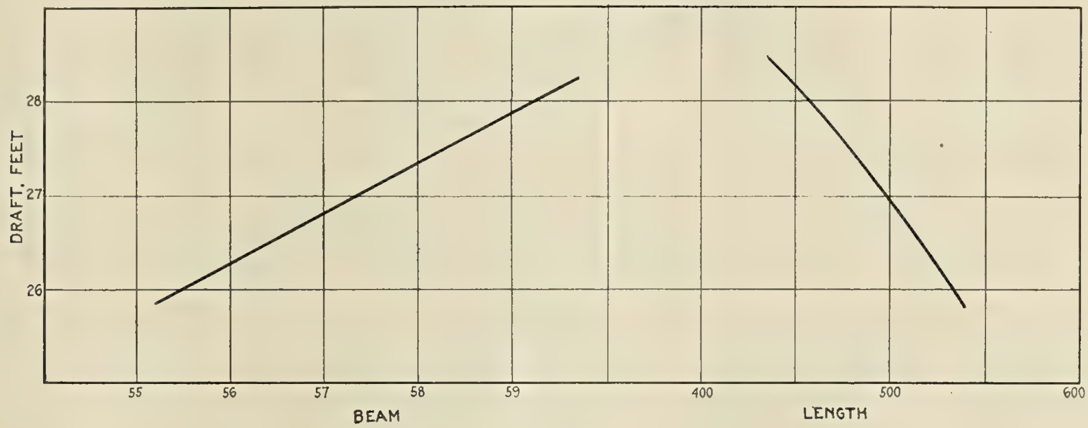

Fig. 3

δ—Hull weight coefficient	.280
v—Center of gravity coefficient	.155
C—Coal per horsepower-hour	2.0
g—Auxiliary coal per hour	.800
B—Admiralty coefficient	.293
p—Horsepower per ton machinery	4.81

As the maximum draft allowed was given as 28 feet, this will be accepted for the first solution for beam, and substituting this in equation (8), we get

$$b = \sqrt{\frac{\dfrac{\alpha d^2}{3}\left(.5 + \dfrac{\alpha}{\gamma} - 3\,v\right) + \alpha\, d \times GM}{.008 + .0745\,\gamma^2}}$$

$$= \sqrt{\frac{\dfrac{.778 \times 28^2}{3}\left(.5 + \dfrac{.778}{.879} - 3 \times .155\right) + .778 \times 28 \times 2}{.008 + .0745 \times .879^2}}$$

$= 59.27$ feet.

Five-place logarithms can be used in this solution, but anything less refined is undesirable.

This now gives a beam which is in agreement with the 28-foot draft assumed; and, using these two quantities, solution can be made for the length from equation (A) giving L in feet. This should be repeated for two more solutions at drafts which are successively different by perhaps .5 foot and the results expressed either in tabular form or by curves similar to Fig. 3; then for any desired draft the other dimension in agreement therewith can be read off.

From this information, then, the most desirable combination of length, breadth and draft can be selected,

Fig. 1.—Army Transport *Thomas* in Honolulu Floating Dry Dock

taking into consideration cost of building, strength, resistance, etc.

So far, no consideration has been given to the question of depth except as involved in the constants selected; but, as depth is equal to draft plus freeboard, the freeboard should next be determined,† taking account of the characteristic features of the hull.

It is obviously highly desirable that a systematic record be kept of designs carried to completion, as only in this way can the constants be satisfactorily estimated for a new design. In general, however, they lie between the limits given below:

Block coefficient (α) .60 — .75 (passenger) .75 — .83 (freight).

Load waterline coefficient (γ) .75 — .85.

Prismatic coefficient (β) .63 — .78 (passenger) .78 — .86 (freight).

Midship section coefficient .95 — .99.*

Hull weight coefficient (δ) .25 — .30.

Center of gravity coefficient (v) .13 — .19.

Coal per horsepower-hour 1.5 — 2.0 (including dependent auxiliaries).

Admiralty coefficient 235 — 290.

Horsepower per ton of machinery, 4.85 — 5.00 freight; 5.00 — 6.00 transatlantic passenger; 6.00 — 7.00 intermediate cargo passenger (large size).

* Present information indicates that the large values are good from a resistance point of view.

† An article on the preliminary determination of freeboard will appear in a subsequent issue.

Replacing Propeller of Vessel of Over 11,000 Tons Displacement in Floating Dry Dock with a Lifting Capacity of only 4,500 Tons

On August 12 the United States Army transport *Thomas,* which is 470 feet 6 inches long overall with a beam of 50 feet 2½ inches and an approximate displacement of 11,050 tons on a draft of 24 feet, was placed in the floating dry dock of the Inter-Island Steam Navigation Company of Honolulu, which is only 352 feet long overall and has a lifting capacity of only 4,500 tons. The *Thomas* was crippled by the breaking of the blades of one of her propellers. As shown by the illustrations, she was placed in the floating dry dock and the stern raised until the propellers were out of water. Between midnight on August 12 and 8 P. M., August 13, three blades of one propeller were removed and new blades substituted, allowing the vessel to proceed on her way with only one day's delay.

It is apparent that as the length of the dock is only 352 feet and the length of the ship 470 feet 6 inches, the bow of the ship overhung the dock 118 feet 6 inches. By a careful inspection of the photographs, it will be seen that the bow was hardly lifted while the stern of the vessel was lifted approximately 20 feet. From this it will be seen that it is practicable to make propeller repairs on a very large steamer with the aid of a comparatively small

Fig. 2.—Replacing Propeller Blades on Army Transport *Thomas*

floating dry dock. This dock was designed by William T. Donnelly, consulting engineer, New York, and in our July, 1914, issue it was fully described, together with a description of the docking of a large caisson which was an exceedingly top heavy structure. These two instances of unusual docking operations give a good idea of the wide range of usefulness of dry docks of this description.

The Classification of Ships

BY ARTHUR R. LIDDELL

American shipowners have sometimes asked what they gained by the classification of their fleets. The usual answers given have been that the registration society exercises a control by impartial surveyors over the construction of the ships and carefully tests the material supplied by makers, and that underwriters regulate their policies in accordance with the classes given. It is sometimes objected that a high-class shipyard can offer the same advantages in these respects, but a little consideration ought to show that this is hardly the case. The control has to be exercised by somebody, and to hand it over to an impartial central body is the cheapest way of carrying it out. The formation of a correct judgment on the scantlings of a vessel that departs to any considerable degree from ordinary types requires a good deal of special knowledge which is not easily acquired. The average chief draftsman has not had the opportunity of seeing more than a certain range of work. If shipbuilders are to exercise this judgment, they must keep specialists to support them. In place of two or three men in the head office of a registration society, the shipping industries must pay the salaries of an expert in the branch in question in each of the shipyards, and, moreover, these experts cannot be expected to work on uniform lines.

The testing of the material is done by the registration societies' surveyors at the makers' works. Any material not up to the standard is stopped at once, and time and friction are saved. If ten shipyards each send a surveyor to do this work, these representatives spend a large part of their time in waiting till portions of their material—sometimes very small ones—are ready for test, whereas a single local testing surveyor of a registration society can deal with one batch after another for different yards. His work costs much less than that of the ten shipyard men and his special experience should enable him to act with greater confidence and authority. If the material is to be tested on delivery, each shipyard must have a testing plant and specialists to use it. Faulty material must be returned, and either the arrival of fresh material awaited or large losses incurred by the substitution for it of unsuitably dimensioned stock. The cost of transport of faulty material, which is considerable, will in the long run have to be borne by the shipping industries in general, though for the moment it may fall on the steel maker alone.

Then, again, there is the control of the building of the ship. The owners' ship surveyor is often a seaman. If he be a naval architect, he will probably be wanting in the desirable quality of sea experience. The seaman may have a carpenter to assist him, but neither seaman nor carpenter will have the requisite special knowledge of materials or of the functions of the different parts of a steel structure. The shipyard also has not always at its command men trained to look at questions of local strength from the required point of view. There again each ship owner must have a specialist on the spot, and the combined salaries of these represent a much greater sum than the cost of control by the local surveyor, who, by the way, finds time to perform other duties as well.

Decisions given by an impartial authority are, in general, likely to be accepted. Controversies are thereby avoided and friction minimized. The question, what strength—i. e., what scantlings—should be given to a proposed vessel, is a very difficult one. A method of gaging it that can be simply applied has not yet been found. The mere application of the rules and tables of the registration society is not in itself sufficient. Any ship that is out of the common run has to be specially treated, and the scantling finally adopted for her is generally the result of special consultation and agreement with one of the bodies that have had a lifelong experience of strength questions and can speak with authority in regard to them. The certificates of such bodies also lighten the responsibility that has to be borne by shipowner and shipbuilder in case of accidents to their vessels. The public is an exacting tribunal and shows no mercy to the owner or builder of a ship that suffers mishap.

It is said that underwriters are prepared to take risks on unclassed vessels. This is, under certain conditions, no doubt correct, but that the possession by a ship of a high class in a good registration society would not tend to lower the premium has to be demonstrated. The underwriter adjusts his premiums in relation to a number of different conditions, and he will probably in all cases be guided to a certain extent by the class or the want of it, even though he does not say so.

But there is yet another side to the business of the registration society, and that is the keeping of the vessels up to the mark as the years roll by, the eventual lowering of their classes on account of deterioration, and the ordering of necessary repairs when a ship seeks port in a battered condition after a storm. This work can be satisfactorily and systematically performed only by a staff of surveyors at the outports who stand under instructions from headquarters and are supplied with all the dates of previous surveys and with the particulars of previous cases of damage experienced by each ship in question.

Finally, when a vessel is to be sold, perhaps to make way for a more up-to-date successor, she is more likely to command a good price if classed than if entirely without a certificate.

A registration society that is wise in its generation and takes an intelligent view of its position and its sphere of action is the friend and advisor of all shipping men. In their register books the societies compile a mass of useful information that is nowhere else attainable, and they supply the sea interests with networks of facilities and with ready advisors who are depositories of general and local information at all frequented corners of the earth. To make use of the work and experience embodied in their rules without supporting them would ultimately be to let rules and register book and all the advantages provided by them go by the board and create the necessity for the uncompromising and undifferentiating government supervision that has in all ages been deprecated and avoided. The practice of dispensing with classification leads entirely in this direction. With the first great mishap, Judge Lynch steps in. Previous high reputations of firms involved are disregarded, and ignorance decrees that perfect safety shall in future be seen to by the nation. But the nation means retired public servants, who will go sure—that is to say, who will set their faces against improvements or developments in every form, because they cannot gage their consequences. The registration society is the outcome of the accumulated professional experience of the shipbuilding, shipowning and underwriting communities, which it focuses and renders accessible to all. It has no interest in the running of risks, and concessions it may make to any client are jealously watched by the rest. Any forward move it may sanction is certain to have been viewed in every possible light, and, in fact, it exercises the same guiding and moderating influence in the shipping industries that an upper chamber of the legislature does in general politics. To replace it by a public department would be to discard the safety valve and work the boiler at half pressure.

It is, indeed, a question for mature consideration, whether the functions of the registration societies could not profitably be further extended so that these bodies exercise more influence than at present on the various sea qualities of the ships they class. In connection with stability, rolling, steering, tendency to ship seas, vibration, arrangement of weights, stowage and some other qualities, there are limits and danger-zones that are, unfortunately, not matters of common knowledge. They might be made so by the training of the rank and file of men engaged in the shipping industries to a higher degree than at present. To do this, however, would be a work of time, and it would cost money. The students of naval architecture at the Technical College in Charlottenburg some years ago issued a pamphlet of warning against overcrowding of their faculty. In this it was shown that the college training cost at least M10,000 per man and lasted some four or five years, and that the posts that might satisfy the aspirations of the successful students were few in number and, owing to concentration of work in large establishments, were becoming still fewer. A minority only of the certificated ones could ever reap the advantages of the money and time spent on their education. In fact, unlimited higher education does not pay, and we are forced back to the old system of the division of labor. Societies with special functions and practically acting as committees of the representatives of the sea industries can exercise sufficiently elastic control over current practice to the best advantage of all concerned.

Monthly Shipbuilding Report.—The Bureau of Navigation reports 94 sailing, steam and unrigged vessels of 15,410 gross tons built in the United States and officially numbered during the month of August. Of these vessels, 13, aggregating 8,669 gross tons, were steel steamships. The largest vessel completed during the month was the steamer *W. F. White* of 7,180 gross tons, built by the American Shipbuilding Company at Lorain, Ohio. Four foreign-built vessels, of 12,599 gross tons, were added to the American merchant fleet during the month.

The steamer *Rose City* of the Portland & San Francisco Steamship Company, Portland, Ore., will be equipped with four Ballin watertube boilers and other equipment at a cost of $50,000 (£10,500).

Calculations for Ships' Forms*

Light Thrown by Model Experiments Upon Resistance, Propulsion and Rolling of Ships

BY REAR ADMIRAL D. W. TAYLOR†

All ship calculations proper are made from the complete lines, namely, sheer, half-breadth and body plans, or from special calculation plans derived from the lines. But in order to get out the lines in the first place, the usual methods of trial and error involve a large amount of calculation. Such drudgery could be largely reduced by the determination, once for all, before delineation, of each line to be drawn, provided this determination did not bring in too much drudgery of its own. This leads to the use of mathematical formulæ of such nature and with such optional coefficients as to enable us to choose in advance the kind of line we wish, with the certainty that the displacement or area will be what is desired. Some devices or formulæ for lines propose to go further and give lines resulting in ships particularly easy to drive, or whose resistance can be calculated from coefficients depending upon the formulæ. Such a proposition, for instance, was put forward by Herr Bauer in 1914 before the Schiffbautechnischen Gesellschaft.[1]

For some fifteen years, at the U. S. Model Basin, there have been used mathematical formulæ, not with the idea that they give lines of minimum resistance, but simply to obtain lines possessing desired shapes. Dealing with a large number of models annually—one hundred and fifty distinct models in some years—even after allowing for the fact that many of them are from complete sets of lines furnished independently or derived from other lines by expansion or contraction, it would be practically impossible to accomplish the work with the force available, if it were necessary to draw each new set of lines by the trial and error method. By present methods, after a little study and practice, a competent draftsman can get out a complete set of lines giving exactly the displacement desired, using nothing from any previous vessel, in not more than five days. Most models, however, are modifications, in a desired direction, of some previous lines, and can be gotten out in less time. Practically all United States naval vessels designed during the last ten years have had mathematical lines.

Formulæ for lines should be as simple as possible and involve the fewest possible optional coefficients. This for the reason that these quantities are not wholly independent, and the more complicated the formulæ and more numerous the optional quantities, the more complicated the relations between the optional quaitities which must be considered in obtaining a fair form. For water lines and curves of sectional area we use a fifth-power parabola as the primary formula. For such a line, of given half-length and half-beam, we may choose, at will, the coefficient of fineness, the tangent or angle of inclination at the extremity, and the curvature amidships. The inclination at the midship section is in every case zero, and the water line must have the proper half-breath at the midship section, which, of course, is not necessarily at the center of length.

For fine sections, with sectional coefficients below 0.7, or thereabouts, a fourth-power parabola is used, the optional quantities being the coefficient of fineness of the section, the flare or tumble-home of the section at the water line, and the dead-rise at the keel. For full sections, with sectional coefficients above 0.7, or thereabouts, we use an arc of a very well-known curve, namely, the common hyperbola. This can be made to give sections practically identical with those from the fourth-power parabola for coefficients in the vicinity of 0.7, so we can pass from one formula to the other without any difficulty. For these full sections the only optional quantities are the coefficient of fineness and the flare or tumble-home at the water line. The dead-rise follows from the nature of the curve, but it is found in practice that for the full sections for which the hyperbola is used, and for ships' forms as they are, the dead-rise angles resulting from the hyperbola are quite satisfactory. The trouble with mathematical formulæ for sections and water lines is that in addition to giving us the curves we want, they are capable of giving us a great many curves that we do not want, and before they can be used with satisfaction, it is necessary to determine how to use the optional coefficients in order to obtain, at will, curves such as are wanted. The details of the formulæ and their applications are given in an appendix, concerning which it may be said that, while desirable, it is not at all necessary that one using the methods should understand the mathematics of them. In one of the illustrations, giving the body plan of a vessel with mathematical lines, each section from keel to water line is calculated mathematically by the methods explained in the appendix.

Resistance

When steam navigation entered upon the rapid development dating from the middle of the last century, it became necessary that former crude ideas as to the resistance of ships and methods of determining the power required to drive a given ship at a given speed should be replaced by ideas and methods more in consonance with facts.

In 1860, or later, we find leading authorities who considered that the whole resistance of a ship was due to surface friction and that for properly formed ships the wave resistance was negligible. All such ideas have now been discarded, and the present accepted ideas as regards resistance of ships are based entirely upon the work done by William Froude and his successors in model tank experiments. Although it is more than forty years since Froude built the first model tank in his garden at Torquay, England, and published most important results of experiments made there, it is only since a comparatively recent date—say the beginning of the present century—that model tanks and their results have been generally accepted as ordinary tools of the naval architect thoroughly to be relied upon. Here and there a sceptic may exist to-day, but the law of comparison as applied by Froude is now generally accepted.

At the United States Model Basin, during the last fifteen years, the Froude methods have been applied to the models of some 189 United States vessels, having a total displacement of about 1,163,874 tons and a value, or cost when new, of about $443,000,000 (£95,000,000). In the cases of two vessels, only, have the results of the trial of the full-sized ship differed materially from what was to be expected from the model results. This was really one case,

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* From a paper presented at the International Engineering Congress, San Francisco, Cal., September, 1915.

† Chief Constructor, United States Navy.

1 "Harmonie der Schiffsformen," by M. H. Bauer, in the "Jahrbuch der Schiffbautechnischen Gesellschaft," 1914.

as the two vessels were sister ships. The probable cause of the discrepancy has long been known, although it acts so seldom in practice that it is apt to be forgotten.

The law of comparison, strictly speaking, requires that not only must the speed of the full-sized vessel be to the speed of the model in the ratio of the square roots of their linear dimensions, but that the pressures around the two must be in the ratio of the linear dimensions. It so happens, however, that pressure does not affect materially the resistance due to surface friction and to the formation and dispersion of waves for either model or ship. As regards the third recognized element of resistance, namely, eddying, the theoretical pressure conditions must be complied with, if the eddy resistances of model and full-sized vessel are to follow the law of comparison; but in nearly all vessels the eddy resistance is not only a small factor, but consists of eddies behind struts, stern post, etc., which are comparatively little affected by pressure. But in vessels with exceptionally full sterns, we may have eddies under the quarters, with accompanying increase of resistance; while corresponding eddies do not appear in the model, although they would appear if the pressure around the model could be reduced to scale. This was apparently the condition in the case of the two vessels above referred to, which required more power than expected to obtain their designed speed.

I would not be understood as stating that the resistance of a full-sized vessel can be determined in advance with minute accuracy by model basin experiments, or by any other method now known. As a matter of fact, the resistance of any vessel is largely due to frictional resistance. For most vessels, this factor is decidedly predominant, and we determine the frictional resistance by estimates based upon experiments made by Froude forty years ago. It is very difficult to determine with minute accuracy the actual frictional resistance of the surface of a large vessel; the workmanship, condition of plating, and other minor factors affect it appreciably, and marine growth may increase friction radically. Experiments in the United States Model Basin, with plates exposed to fouling, near Norfolk, Va., indicated that in seven months, from July to February, a marine growth by no means excessive, consisting mostly of barnacles, averaging in total weight when dry one-quarter of a pound per square foot, would increase the frictional resistance by as much as 210 percent. Moderate ordinary corrosion with no appreciable fouling will also materially increase frictional resistance.

In connection with the friction of models, it may be of interest to record that the experience of the United States Model Basin, as regards variation of friction with temperature, does not appear to be in accord with the rather discordant results obtained in Great Britain. In the early days of the establishment, in 1899-1900, Froude's frictional coefficients, deduced from experiments with varnished wooden planes were carefully checked as regards planes 20 feet long and 18 inches wide (6.1 m. x 0.457 m.). These also were varnished wooden planes, and the results were in substantial agreement with those of Froude. During the last few years, information has been published as regards the variation of resistance of models with variation of temperature in the model tank for the tank of the Messrs. Denny, at Dumbarton, Scotland, and for the William Froude tank at Kew, England. Sir Archibald Denny * stated that "the correction should be 4 percent for 10 deg. F." In the same discussion, Mr. Baker† stated "With regard to skin friction correction, Sir Archibald Denny takes 4 percent correction on the whole for a 10-degree change in temperature. We ourselves, correct 3 percent for the same range of temperature, but we only take our correction on the skin friction, because, so far as I can see, temperature cannot affect the wave resistance."

In 1912 a special investigation of this matter was undertaken at the United States Model Basin, it being planned to run a model of a battleship and a model of a torpedo boat destroyer monthly, and note temperature upon each occasion. The models used at the United States Model Basin are of wood, varnished and before a run, each model was smoothed by sandpapering and revarnished. The ordinary variation of temperature of the water in the United States Model Basin is from about 80 degrees in the height of summer to about 54 degrees in mid-winter. The temperature would fall much lower in the winter, except for the fact that the building is thoroughly heated in cold weather. In the winter of 1913, after filling the basin with fresh, cold water, the trial models were run in water as cold as 44.5 degrees. The results of these experiments were quite consistent. The only anomaly developed was when, after nine months, there had been such an accumulation of varnish that the varnish was scraped off and the models revarnished. This resulted in an anomalous reduced resistance of 3 percent. The results may be summarized as follows:

With change of water temperature there was a perceptible change in the resistance of both the battleship and destroyer models. These changes in resistance, due to temperature, were apparently more closely related to the frictional resistance than to the residuary resistance, and the percentages given below are based on the frictional resistance alone. For the battleship model, the decrease in resistance for 10 degrees F. increase in temperature was about 1.9 percent of the frictional resistance, and for the destroyer model 2.3 percent of the frictional resistance.

It is seen that this variation is much less than that apparently occurring in Great Britain. The difference may be due to one or a number of different causes. The models used in the United States Model Basin are 20 feet (6.1 m.) instead of 12 feet to 14 feet (3.66 to 4.27 m.) as usual in the British tanks; the models are wood, varnished, instead of paraffine; the average temperature in the Washington tank is materially higher than that of the British tanks; the water used, which is taken from the Washington City mains and has passed through sand filters, may be different in quality. Although the water used in filling the tank at intervals of from a few months to several years is taken direct from the Washington City mains, the small stream kept constantly running in is refiltered with a small amount of alum injected prior to refiltering.

It has been the endeavor of many people in the past to devise a formula expressing the resistance of a ship. The numerous results of the model-basin experiments which have been published in the last ten or fifteen years have been rather discouraging to the development of any such formula.

We have learned that a factor which is of importance at one speed is almost negligible at another. If we take two vessels, identical in dimensions and displacement, and build one with fine ends and the other with full ends, the fine-ended vessel will offer much less resistance over a certain range of speed, while at extreme speeds the full-ended vessel will be materially better.

Some years ago there were published the results of experiments with a large number of models at the U. S. Model Basin,* where proportions and coefficients had been varied systematically. The general results of this so-called standard series agree very closely with the general results from a very large number of additional models of

* Page 63, Transactions of the Institution of Naval Architects, 1914.
† Page 64, Transactions of the Institution of Naval Architects, 1914.

* "The Speed and Power of Ships," D. W. Taylor, 1910.

usual types tried at the U. S. Model Basin, and also agree very well with exceptional results from other model basins. If a formula or formulæ could be devised which would accurately express the plotted results of the standard series referred to, we should have the desideratum of many years. Attempts to do this have not been very successful, but the results, as plotted, show the broad features of the resistance of ships of usual types.

In the first place, the actual size of a vessel, its displacement, is, of course, the primary factor in its resistance. In the second place, the proportions come into play. Viewing this aspect of the case, the most important feature is the length used for a given displacement. Beam and draft are comparatively minor factors, while the length is a major factor. Length is of peculiar value for cutting down the wave-making resistance; hence, we find that for fast vessels, where wave-making resistance is of such importance, the total resistance may nearly always be decreased by increasing the length. The third factor of primary importance is the longitudinal or prismatic coefficient, or what is in a way the same thing, the nature of the ends, whether fine or full. This is a very important factor. For speeds which are moderate in proportion to the length of the vessel—that is, when the speed-length ratio, or speed of vessel in knots divided by the square root of the length in feet is below about 0.8 (0.442 in metric units)—the large midship section and fine ends are nearly always favorable to speed. About a speed-length ratio of 0.95 (0.525), there is a somewhat indeterminate region where variation of the longitudinal coefficient does not produce much effect. For high speeds, however, say of speed-length ratio above 1.25 (0.695), we gain, by reducing the midship section and using large longitudinal coefficients, even up to 66 percent, and their associated full ends.

There appears no question that the fore body has much greater influence upon resistance than the after body. Experiments, described in the Transactions of the Society of Naval Architects,* show that radical variations in the shape of sections of the after body produced comparatively little effect upon resistance. The shape of the sections forward, however, does materially affect the resistance, and for the great majority of vessels there is no doubt that fine or hollow lines forward near the surface of the water, resulting in forward sections full below water, even bottle-shaped in many cases, are favorable to speed. Many sea-going people and naval architects are opposed to hollow water-lines forward, but there are indications that the results of model-tank experiments are making more and more impression upon practical people; and although we may not again find in fashion the very hollow lines of Scott Russell, we are certainly much nearer to this extreme than we were ten years ago.

Sir Archibald Denny, in his presidential address this year at the Institute of Marine Engineers, pointed out that of late years there has been a decided reduction in the block coefficients of low-speed cargo vessels, due to unsatisfactory experience at sea with those of coefficients of 0.80 or over. It would not have been necessary to settle this question by trial and error on full-sized ships at sea, if careful investigations of models had been carried out. There have now been published sufficient results of systematic model investigations† to enable the competent naval architect, dealing with merchant vessels, to settle with quite satisfactory accuracy the relative financial results to be expected in service from vessels of varying form and fullness of usual types. For special and unusual types and for vessels for high speed in shoal water, it is necessary to go largely by guesswork or to have recourse to model experiments, which will be found, by far, the most profitable capital investment in such cases.

(*To be continued.*)

* "Some Experiments with Models having Radical Variations of After Sections," D. W. Taylor, Transactions of Society of Naval Architects and Marine Engineers, 1914.

† "Some Results of Model Experiments," R. E. Froude, Transactions of the Institution of Naval Architects, 1904. "The Speed and Power of Ships," by D. W. Taylor, 1910. "Model Experiments on the Resistance of Mercantile Ship's Forms," G. S. Baker, Transactions of the Institution of Naval Architects, 1914.

International Engineering Congress

The most important meeting of engineers that has taken place in this country for many years is the International Engineering Congress, which was opened in San Francisco on September 20 and continued for six days. The following papers were presented before the section devoted to naval architecture and marine engineering:

Tuesday, September 21

"Ship Calculation, Resistance and Propulsion." By Rear Admiral D. W. Taylor, U. S. N., chief constructor, United States Navy.

"Ocean Freighters." By Ernest H. Rigg, naval architect, New York Shipbuilding Company, Camden, N. J.

"Recent Developments in Japanese Shipbuilding." By Dr. E. Terano, professor of naval architecture, Tokyo Imperial University, Tokyo, Japan.

"Bulk Freight Vessels of the Great Lakes." By Professor Herbert C. Sadler, professor of naval architecture, University of Michigan, Ann Arbor, Mich.

Afternoon Session

"River, Lake, Bay and Sound Steamers of the United States." By Andrew Fletcher, president, W. & A. Fletcher Company, Hoboken, N. J.

"Special Types of Cargo Steamers for the United States Coast to Coast Trade Through the Panama Canal." By George W. Dickie, naval architect, San Francisco, Cal.

"The Development of the Sail Yacht, Steam Yacht and Motor Yacht in American Waters." By William Gardner, naval architect, New York.

"The Lightship." By G. C. Cook, Department of Commerce, Lighthouse Service, Washington, D. C.

Wednesday, September 22

"Warships of the First Line of Battle." By Col. E. Ferretti, chief constructor, Royal Naval Arsenal, Naples, Italy.

"The Submarine." By R. G. M. Robinson, managing director, Lake Torpedo Boat Company, Bridgeport, Conn.

"Present Conditions of the Submarine." By Max A. Lauberf, late chief constructor, French Navy, Paris, France.

"Modern Marine Gun Armament." By Lieut. H. F. Leary, U. S. N.

"General Problem of Naval Warfare." By Lieutenant-Commander D. W. Knox, U. S. N.

Thursday, September 23

"Marine Boilers and Boiler Room Equipment." By Charles F. Bailey, chief engineer, Newport News Shipbuilding & Dry Dock Company, Newport News, Va.

"The Development of the Marine Steam Turbine." By Lieutenant-Commander H. C. Dinger, U. S. N.

"The Application of the Steam Turbine to Marine Propulsion." By J. F. Metten, chief engineer, William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa.

"Recent Development in Marine Engineering in Japan." By Dr. M. Tsutsumi, chief engineer surveyor, Japanese Mercantile Marine Bureau, Tokyo, Japan.

"Coaling Plants and Floating Cranes of the Panama Canal." By F. H. Cooke, civil engineer, U. S. N.

"Cargo Handling Methods and Appliances." By H. McL. Harding, consulting engineer, New York.

"Some Economic Fundamentals of Freight Handling." By David B. Rushmore, chief engineer, power and mining department, General Electric Company, Schenectady, N. Y.

"The Modern Trend in American Marine Terminals." By Robert H. Rogers, power and mining engineering department, General Electric Company, Schenectady, N. Y.

"Cargo Handling Methods and Appliances." By James A. Jackson, power and mining engineering department, General Electric Company, Schenectady, N. Y.

Friday, September 24

"Fuel Oil." By E. H. Peabody, chief engineer, marine department, Babcock & Wilcox Company, New York.

"The Application of Diesel or Heavy Oil Engines to Marine Propulsion." By G C. Davison, vice-president, Electric Boat Company, Groton, Conn.

"The Diesel Motor Applied to Marine Purposes." By C. Kloos, technical director, Werkspoor, Amsterdam, The Netherlands.

Afternoon Session

"Terminal Works, Dry Docks and Wharves of the Panama Canal." By H. H. Rousseau, civil engineer, U. S. N.

"Aids to Navigation of the Panama Canal." By W. F. Beyer, Milwaukee, Wis.

"American Graving Dock Practice." By Leonard M. Cox, civil engineer, U. S. N.

"Dry Docks Recently Built in Italy." By Professor Luigi Luiggi, Dr. of Sc., Rome, Italy.

Design of Small Screw Propellers*

Size and Location—Safe Peripheral Speed—Preparation of Actual Working Drawings

BY D. H. JACKSON

This paper deals with the subject of small screw propellers, purely as it affects the draftsman or designer. The author has not touched upon any of the classic experiments and the more or less abstruse theories deduced from them, but has endeavored to treat the matter throughout from a fairly practical standpoint, as covered by his own experience. So far as the draftsman is concerned, the first question to engage his mind on the subject of a propeller is:

(*a*) How much room will the propeller occupy? If the diameter be proportioned on past experience, will the consequent shaft-line be convenient and practicable? This consideration is often of great importance when dealing with small propellers.

(*b*) Will the peripheral speed of the propeller be within safe limits?

These two points have usually to be settled in short time and at short notice. Often, indeed, the diameter and pitch of propellers, and the exact position of shaft-line, have to be fixed at the time of tendering for an order, which is usually a very strenuous period.

This task being safely completed, the unfortunate and long-suffering draftsman is granted a breathing space until the time arrives for:

(*c*) The preparation of actual working drawings of the propeller.

There are pitfalls awaiting the unwary, even in this process. They are, however, not usually of a serious nature, and the author is bold enough to hope that certain of the notes contained in this paper may help to smooth the way of the draftsman over some of these points.

Now let us revert to the first consideration:

How Much Room Will a Propeller Take?

Probably the great stand-by of the draftsman in the matter is one or other of the well-known formulæ:

(1) Diameter of propeller is proportional to

$$\sqrt[3]{\frac{I.H.P.}{R}}\text{, or else}$$

(2) Diameter of propeller is proportional to

$$\sqrt[2]{\frac{I.H.P.}{S3}}$$

Where I. H. P. = indicated horsepower transmitted through *one* propeller.

R = revolutions per minute. S = speed of vessel, in knots.

Now, in spite of the careful experiments, deductions, etc., on which these two formulæ are based, the author is of the opinion that equally close results, together with greater handiness of calculation, may be obtained with the formula:

(3) Diameter of propeller is proportional to

$$\sqrt[2]{\frac{I.H.P.}{S}}$$

Obviously, such a formula only holds good for cases of close similarity, in form of vessel and speed. The Tables I and II annexed give some characteristic comparisons derived from the use of formula (3). Table I shows a number of examples of small vessels of full body; displacements varying from 100 to 500 tons; speeds up to about 14 knots. Table II shows a number of examples of vessels of from 700 to 1,000 tons displacement, and of high speed. Needless to say, where shaft horsepower and indicated horsepower are to be compared, the value of I. H. P. must be multiplied by a suitable coefficient (generally about 0.9) to obtain the corresponding S. H. P. For ships fitted with Diesel engines, this coefficient should be diminished to about 0.8 to 0.85.

TABLE I

No.	I.H.P. through one Propeller	Speed in Knots	$\sqrt{\frac{I.H.P.}{S}}$	Dia. of Propeller	Dia. of Propeller / $\sqrt{\frac{I.H.P.}{S}}$
1	600	14	6.54	4.67 feet	0.71
2	400	10	6.33	4.75 "	0.75
3	600	10	7.75	6.00 "	0.775
4	600	10	7.75	5.90 "	0.76
5	800	14	7.56	6.00 "	0.795

In connection with Table I it may be noted the propeller in example No. 1, ran at about 200 revolutions per minute, while that in No. 5 example ran at about 350 revolutions per minute.

TABLE II

No.	S.H.P. through one Propeller	Speed in Knots	$\sqrt{\frac{S.H.P.}{S}}$	Dia. of Propeller	Dia. of Propeller / $\sqrt{\frac{S.H.P.}{S}}$
1	2,200	27	9.02	4.00 feet	0.443
2	4,960	28.2	13.3	5.54 "	0.417
3	8,250	30.6	16.4	6.75 "	0.41
4	12,250	32	19.6	7.67 "	0.39
5	8,670	33	16.2	7.00 "	0.432

It will be noticed that example No. 4 in Table II shows a considerable discrepancy in the value of

$$\frac{\text{diameter of propeller}}{\left(\sqrt{\frac{S.H.P.}{S}}\right)}$$

That particular ship was of a bad form for the high speed at which she was driven. The propellers described in Table II were all driven by steam turbines at, say, 600-650 revolutions per minute.

The above two tables will naturally suggest the construction of a curve in which the values of

* A paper read before the Institute of Marine Engineers, London, February, 1915.

$$\frac{\text{diameter of propeller}}{\left(\sqrt{\dfrac{S.H.P.}{S}}\right)}$$

are plotted against corresponding values of the block coefficients of displacement of the ships under consideration. Such a curve may readily be drawn by any draftsman to suit the class of work with which he may be dealing. For obvious reasons the author is not at liberty to publish such a curve drawn from his own experience. It must be

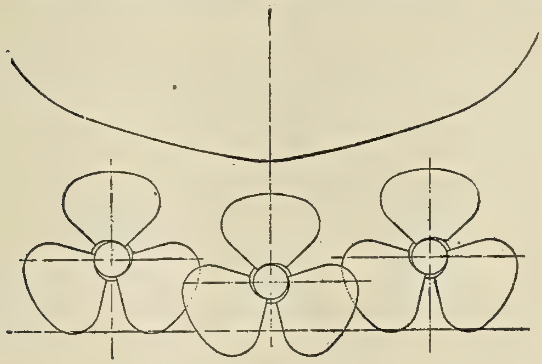


Fig. 1

borne in mind, however, that with vessels of high speed, results calculated in this way upon the block coefficient of displacement may be seriously upset by a bad design of hull, particularly where the after-body is of unsuitable form, as exemplified in Table II, No. 4.

Tip Clearance

The question of diameter being settled, the next point, perhaps, is that of tip clearance. This must, without doubt, be greatly influenced by the peripheral speed at which the propeller is to run. For propellers running at

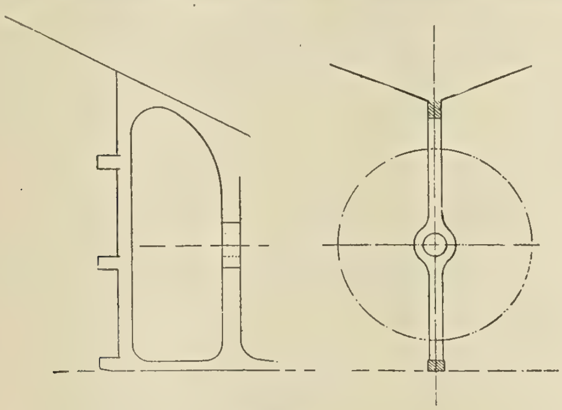


Fig. 2

very high speeds, such as those fitted in turbine-driven vessels, it appears that the clearance between the propeller circle and the ship's skin should not be less than about 18 inches; which figure might, when absolutely necessary, be reduced to 16 inches, although many designers stand out for not less than 24 inches of tip clearance for propellers of this class. The writer has in mind a vessel having tip clearance, between the propeller circle and the ship's skin of 18 inches, with the propellers running at a peripheral speed of about 15,000 feet per minute. These particular propellers proved themselves remarkably efficient in every way, in spite of the high peripheral speed and relatively small clearance. There is no doubt that with turbine-driven vessels having three or four screws a great loss of efficiency is caused by overlapping of the propeller circles, as shown in Fig. 1. This fault should be carefully avoided by the designer as far as possible.

Turning now to propellers running at slower speeds, it is evident that the tip clearance may be greatly reduced. Probably the figure may be very much smaller where the point of minimum clearance occurs against the skin of the ship than where the propeller revolves in the ordinary type of stern frame, as illustrated in Fig. 2. This amounts to saying that twin screws may have smaller clearance than single screws. The same point is borne out by usual

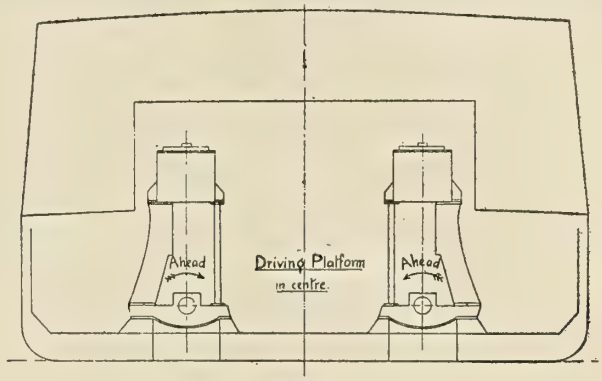


Fig. 3

practice in the construction of raised propeller steamers (in which, to secure a shallow draft, the propeller works in a tunnel formed in the stern of the vessel). In many such steamers the tip clearance has not exceeded 1½ inches, with peripheral speeds of some 3,000 feet per minute. In connection with vessels of this class it is worth noticing that there appears to be no loss of efficiency caused by the propellers of twin screw steamers turning inward, while the consequent improved accessibility of the engines (see Fig. 3) is undoubtedly a great advantage.

Pitch

On the subject of pitch of propellers little need be said; most designers have ample data concerning slip upon which to base their calculations. Here it might be noted that the mistake is occasionally made of using a formula:

$$\text{Pitch} = \frac{\text{speed in knots} \times 101.3 \times (100 + \text{percentage of slip})}{\text{revolutions per minute} \times 100}$$

This should, of course be written:

$$(4) \quad \text{Pitch} = \frac{\text{speed in knots} \times 101.3 \times 100}{\text{revs. per min.} \times (100 - \text{percentage of slip})}$$

The use of the wrong formula has the effect of reducing the result obtained, thereby probably making for an inefficient propeller. Some few engineers, in spite of the experimental research of the standard authorities on propellers, with the obvious deductions therefrom, are inclined to design propellers for very small slip; it seems to be well borne out that for small vessels of fairly fine form and of speeds ranging from 10-12 knots upward, slips may be as high as 20 percent, or even in some cases 25 percent, without necessarily indicating a lack of efficiency. It is certainly desirable that the ratio of pitch to diameter should be kept fairly high, which naturally involves increased slip, if the engines are to run at their full designed speed.

The preliminary figures of diameter and pitch having been settled, there remains:

The Preparation of Working Drawings

Here the question of blade area becomes important. Now the blade areas of propellers for similar conditions

may be compared by means of a formula analogous to that (No. 3) dealing with diameter of propeller circle as follows:

(5) Blade area is proportional to $\sqrt{\frac{H.P.}{S}}$.

In the writer's opinion the most desirable figure to compare in this way is what is known as the projected area of the blades. Another useful means of calculating the blade area required depends upon the thrust per unit surface of projected blade area. This figure may be as high as 12-14 pounds per square inch for vessels of high speed

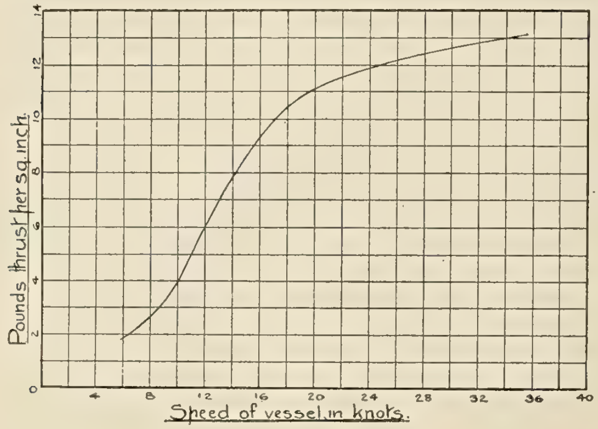


Fig. 4

(say 25 knots and upward); while for quite small vessels (say 60 feet length or thereabout) of moderate speeds, the corresponding figure comes down to about three pounds per square inch. The curve (Fig. 4) in which thrust per square inch is plotted against the speed of the vessel, may serve to give some idea of the figures allowable.

Scantlings of Boss and Blades

The next point to be considered is the axial length of the propeller boss. This often has to be settled before the actual working drawings of the propeller are prepared, because of its relation to the design of the tail-end shaft. It must be noted, in connection with the following remarks, that the common practice with propellers of the size herein discussed—up to six or seven feet diameter—is to cast the blades solid with the boss. For propellers of normal form, such as would be fitted to vessels of moderate speed, the axial length of boss will be from one-eighth to one-sixth of the diameter of the propeller. The diameter of boss bears a close relationship to the thickness at root of blades, and must be considered in connection therewith. These two points will be dealt with later. The taper of the coned bore of propeller to suit the tail-end shaft is commonly made 1 inch diameter in 10-inch length. A finer taper, viz., 1 inch diameter in 12-inch length, is often used; there seems, however, to be no great advantage to be gained by this fine taper, while the difficulty of withdrawing the propeller is certainly increased, giving rise to the use of much bad language, for which the designer is, in part at least, responsible.

For obtaining the thickness at root of blades a number of formulæ are in common use:

(6) $T = \frac{1}{2}$ inch per foot of diameter for cast iron, $\frac{3}{8}$ inch for gun metal, 5/16 inch for cast steel or bronze.

(7) $T_1 = \sqrt{\frac{d^3}{n \times b} \times K + C}$. (Seaton.)

(8) $T^2 = \frac{N \times I.H.P. \times (D - d_1)}{B_1} \left(\frac{d_1}{P \times S} + \frac{20}{R.D.} \right)$ (Barnaby)

Probably the most reliable formula for all cases is the Admiralty formula:

(9) $M = \frac{B \times T^2 \times R \times P}{I.H.P. \times (D - d_1)}$

T = thickness of blade at surface of boss, in inches. T_1 = thickness of blade at center of shaft, in inches; see Fig. 5 (a). d = diameter of tail-end shaft, in inches. d_1 = diameter of boss, in inches. D = diameter of propeller, in feet. n = number of blades in one propeller. b = breadth of blade at root, in inches, measured parallel to shaft (see Fig. 5 (b)). B = breadth of blade at root, in inches, measured as in Fig. 5 (c). B_1 = breadth of blade at root, in inches, measured as in Fig. 5 (d). R = revolutions per minute. P = pitch of propeller, in feet. $I. H. P.$ = indicated horsepower transmitted *through one blade*. S = speed of vessel in knots. $C = \frac{1}{4}$ inch, K = 1.5, N = 2.0 (all of manganese bronze).

Now M, the constant in the Admiralty formula, has for an ordinary manganeze-bronze propeller a value of from 90 to 120, according to circumstances, with proportional values for cast iron or cast steel. A propeller was recently designed to work in rough, broken water, where whirlpools, rapids, small branches of trees and other unpleasant incidents were commonly to be met with. For this purpose the constant M for a propeller 6 feet diameter, 6 feet 6 inches pitch, of manganese bronze, was made equal to

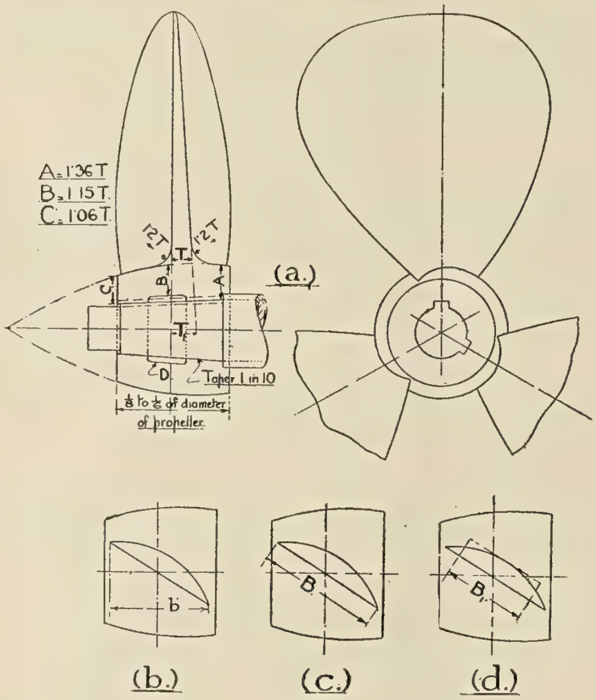


Fig. 5

130. This propeller has given satisfaction in service, and up to the present still has its full complement of blades.

In order that a sound casting may be obtained, it is of the utmost importance that the thickness of metal at the boss should be carefully proportioned to suit that at the root of the blade. Fig. 5 (a) shows proportions which give good results. The thickness of metal in the boss should not be less than that shown, but may be more if desired. A should, however, be greater than B, and B should be greater than C. The founders generally prefer, especially in bronze propellers, that the propeller should be cast without the recess indicated at D, this recess being afterwards machined out when the propeller is bored. Such preference may possibly be due to the practice of

charging for castings by weight. In any case, the axial length of the recess should not exceed about one-third of the length of the boss. Two keys must be fitted, and it is an advantage to arrange each keyway in the propeller to

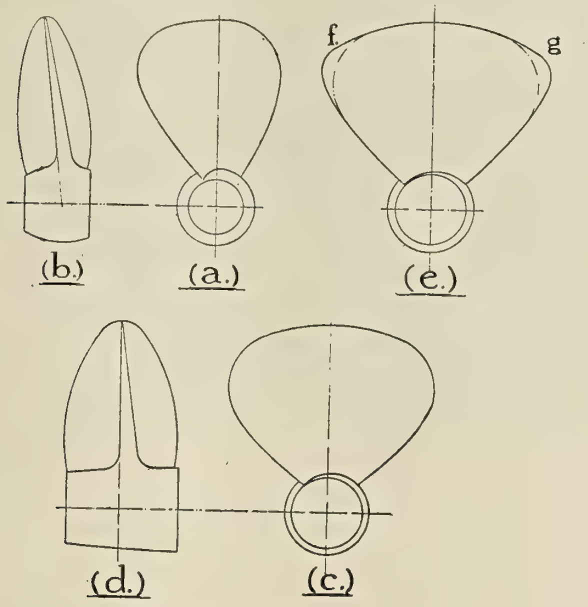


Fig. 6

come opposite to the root of a blade. Hence a four-bladed propeller will have two keys placed 90 degrees apart, while those in a three-bladed propeller will be arranged 120 degrees apart. See also Fig. 5. It may be noted that the crushing load on the side of the keys has been allowed as follows, with satisfactory results:

Crushing load on side of key in shaft, 22,000 pounds per square inch.
Crushing load on side of key in propeller, 18,000 pounds per square inch.
} Assuming one key to transmit 2/3 of total torque.

These are, however, high values, and must certainly not be exceeded. The thickness at the tip of the blades of an ordinary manganese-bronze propeller need not exceed 3/8 inch for a propeller 6 feet in diameter, while for a high-speed propeller of that size, with good tip clearance, it may be 1/4 inch with perfect safety.

Shape of Blade

Much has been written, many ingenious theories have been advanced, and many equally ingenious designs have been registered and patented, all dealing with the shape of propeller blades. And, speaking very broadly, not one of these ingenious designs is any better than its fellows, and not one shows any real superiority over the simple blade form which is commonly adopted. General experience and practice lead one to the conclusion that for propellers of moderate speed, the type of blade form shown in Fig. 6 at (a) gives good results. It is probably also an advantage for the blade to be set back as shown at (b), instead of normal to the shaft centerline, as indicated in Fig. 6 at (c) and (d). In propellers of the latter class, where very wide blades are common, it is well to avoid blades of the form shown at (e) in Fig. 6. Such a blade form does not give good results, probably because the mechanical weakness of the corners of the blade indicated at (f) and (g) causes deformation of the blade under working conditions. A propeller having blades of that form might possibly be improved by the removal of these corners, in spite of the reduction of area entailed.

Projection of Propeller Blades

With regard to the actual projection of propeller blades, the following method was evolved by the writer for his own use. It differs from most methods commonly employed in that it gives an absolutely correct projection of the propeller, and also gives a correct value for the developed area. Especially with the very wide forms of blade common in propellers for turbine-driven vessels of high speed, the inaccuracies involved with the usual methods of projection are sometimes of some consequence.

Referring to Fig. 7, the section of boss and blade is drawn from figures obtained in the manner previously

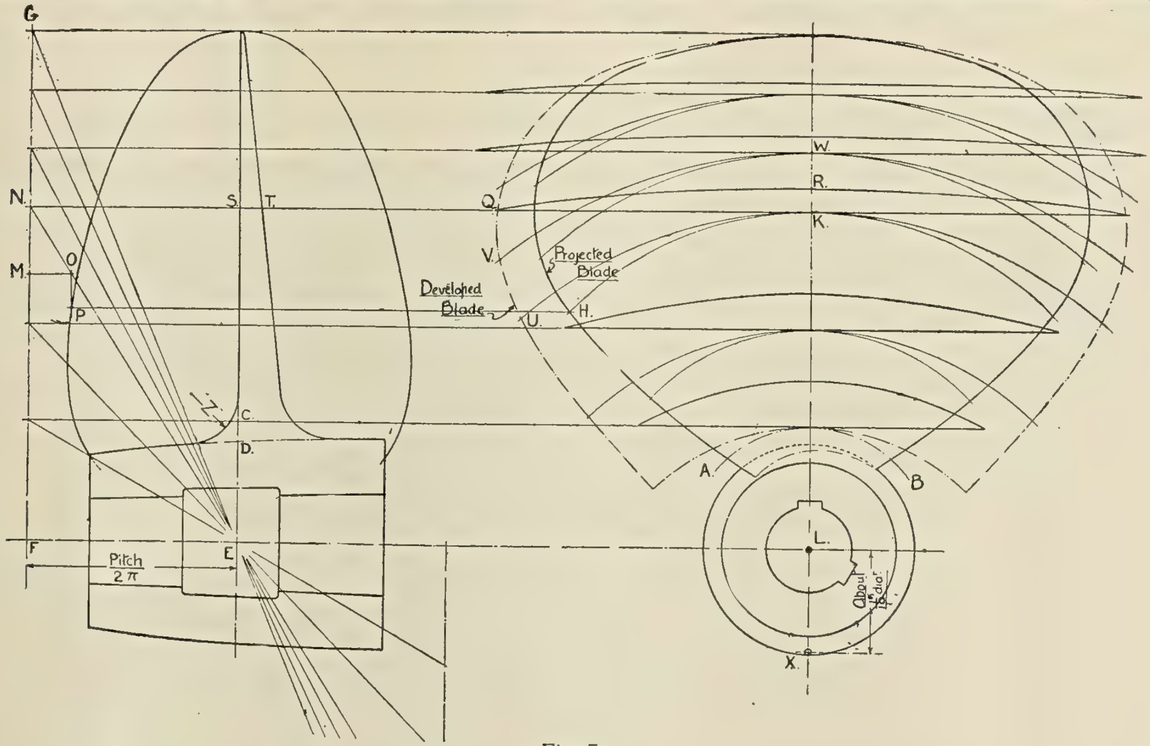


Fig. 7

described under the heading "Scantlings of Boss and Blades." The projected blade is next drawn to give the required area and blade form. The projected area should be reckoned on that part of the blade outside the circle *AB*, the distance *CD* being made equal to one-third of the radius *Z*. The line *FG* is drawn parallel to the working surface of the blade, in the usual manner, the distance *EF* being equal to

$$\frac{\text{Pitch of propeller}}{2\pi}$$

The length of arc *HK* (which is drawn about the center of propeller *L*) is measured along the line *FG*, from *F*, giving the point *M*. This is readily done by means of a flexible steel scale, a flexible batten, or other similar means. The point *M* is projected back on to the pitch line *NE*, corresponding to the arc *HK*, giving the point *O*. The point *O* is projected perpendicular to *EF*, to meet the projector drawn from *H*, parallel to *EF* in the point *P*. Then *P* is the side elevation of the point *H* at the edge of the propeller blade. The length *OE* is the actual length of the helical arc, *HK*, on the surface of the blade. Transferred to *KQ*, this length gives a half developed section of the blade, at the radius *LK*, *KR* being equal to *ST*. A circular arc, *KU*, is drawn about the center *X*, the distance *LX* being equal to about one-tenth of the diameter of the propeller. This same point *X* is the center of all corresponding arcs—e. g., *WV*. Now if the straight-line length, *OE*, be transferred to the circular arc *KU*, measuring from *K* to *U*, then *U* is the corresponding point to *H* on the developed or expanded blade. This process being repeated, the side elevation and developed view of the blade are obtained as shown. The side elevation is a correct projection of the blade, and the development of the blade gives the correct developed area, together with a good approximation to the shape. It is, of course, impossible correctly to develop the shape of a propeller blade on to a flat surface. The foregoing method of projection may readily be adapted to deal with propellers having either set-back blades or blades of increasing pitch. The methods of adaptation will be obvious to anyone accustomed to the design of propellers.

The writer makes bold to hope that these notes on propeller design may have touched upon some points which are not as a rule made clear in text-books, but which are of real interest to the propeller-draftsman. In conclusion, the writer's thanks are due to Mr. H. E. Yarrow for permission to publish certain of the foregoing notes.

Modern Submarines in War and Peace—IV

Motive Power of Submarines for Surface Work—The Heavy Oil Diesel Type Engine—Periscopes

BY SIMON LAKE

The internal combustion engine is the "heart" of the submarine. It is the only motive power thus far evolved suitable for submarine use. When properly designed and built, it will be "ideal" for the service.

The internal combustion engine has the advantage over any other known "prime motor," in that it can be started or shut down instantly. This is of the first importance, as it permits of quick submergence or emergence, either to "submerge" and escape from a high-speed surface destroyer, or to "emerge" and capture a merchantman. It also permits of comparatively high speeds and larger radius of action submerged, when installed in a manner I shall indicate later in connection with "high speed submarines." It weighs less per horsepower, takes up less space, and requires less fuel per hour than any other reliable prime motor, unless something radically new is evolved. The internal combustion engine is therefore bound to survive as the prime motive power for submarines.

The Argonaut's Engine

The writer was the first to use an internal combustion in a submarine boat (in the *Argonaut*). This first engine was a heavy duty engine of rugged construction, and gave but little trouble. It weighed over 75 pounds per horsepower. This type of engine, with but slight modifications, was installed in six other boats built subsequent to the *Argonaut*. They also worked satisfactorily for several years, and as long as I had knowledge of them (they were sold abroad) they always gave satisfactory and reliable service.

The first gasoline (petrol) internal combustion engines installed in the Holland boats were also of rugged construction, and the writer has been informed by various officers in our submarine service that they are reliable and gave but little trouble. It is known that, after twelve years' service, some of them are still doing good work. The boats in which these engines were installed were slow speed boats, making only from eight to nine knots on the surface. A natural desire on the part of the Government was to secure increased speed. They sent out requirements to submarine boat builders calling for increased speeds within certain limits of cost.

The submarine boat builders said: "Certainly, we can give you increased speed, if the engine builders can give us engines of the necessary power to go into the available space, and within a certain weight to thus enable us to get the power plant within a certain size vessel possessing the fine lines to give the required speed within the limit of the appropriations." The engine builders said *they could do it*.

The first, as I remember, to break away from the slow speed, heavy duty type was a celebrated Italian firm. Then two large and well-known German firms followed, then a celebrated English firm, and certain American firms claimed they could build reliable, compact, high speed engines on very much less weight than we had been using. I remember one American firm offered engines as low as 20 pounds per horsepower. Fortunately, we had sense enough to refuse to accept an engine so light as that, but we, as well as all other submarine boat builders, both in this country and abroad, did accept contracts which required engines very much less in weight than the old, slow, heavy duty type first used, and there has been "wailing and gnashing of teeth," both by the submarine boat builders and by the engine room forces, in the world's submarine navies ever since.

The first light weight engines built by the Italian firm

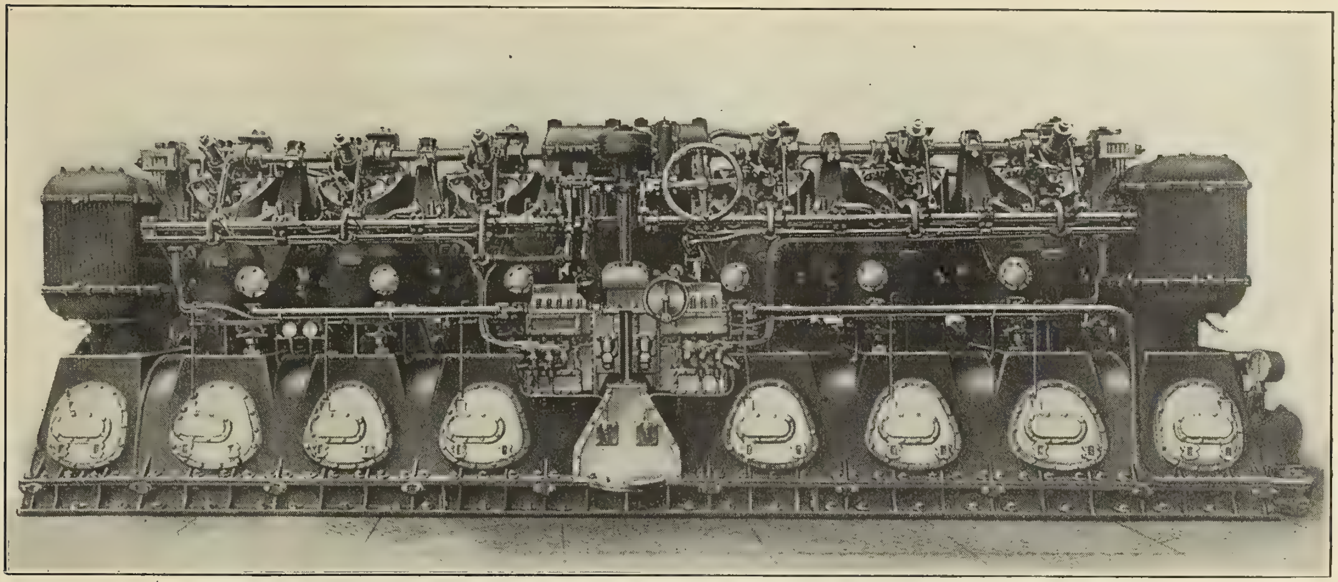


Fig. 33.—Latest Model of Krupp, Six-Cylinder, Two-Cycle, Diesel Engine

Scavenging cylinders are arranged at each end, high-pressure pumps for injecting fuel and for starting and maneuvering purposes, as well as the control gear, is located at the center of the engine. Just previous to the war the Krupps had a large number of these engines under construction.

"smashed up" in short order. The German engines followed suit, and the losses to this firm, or to the shipbuilders, must have been enormous, as a large number of engines were built by them before a set was tested out in actual service. The test of an engine in the shop, on a heavy foundation, open to inspection on all sides, and with expert mechanics in constant "touch" with the engine, does not mean that this same engine will prove satisfactory in the restricted space available in a submarine boat when run by other than expert engine-building mechanics.

I was present at a shop test of one of the German engines referred to, and under shop conditions it appeared to work very well, so well, in fact, that I took an option for my firm to build from the same designs in America. When the engine was tried out, however, in one of the German submarines, it rapidly deteriorated and, figuratively speaking, smashed itself into "junk" in a few weeks. Cylinders and cylinder heads cracked, bed plates were broken and crankshafts twisted or broken. It was evident that the design was too light all the way through.

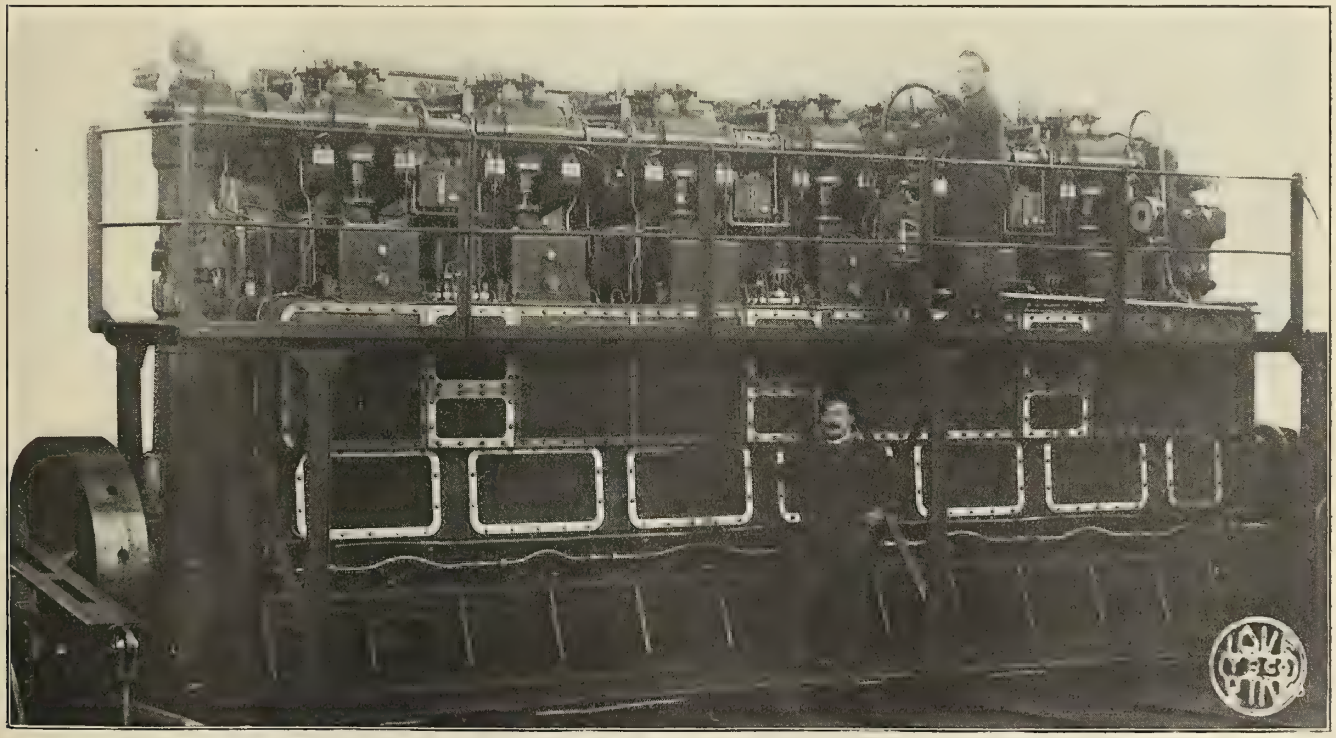


Fig. 34.—Fiat—San Giorgo, Six-Cylinder, Two-Cycle, Diesel Submarine Engine, Designed to Develop 1,300 Brake Horsepower at 350 Revolutions per Minute

This is the largest submarine engine that has so far been built, of which the author has any knowledge. It was built for one of the German submarines, and was tested out and had successful shop tests of twenty-four hours' duration at full power, and six days' and six nights' continuous run at four-fifths full power, just previous to the beginning of the present war. No information is at present available as to its operation in actual service on board the vessel for which it was designed.

Our Congress last year made an appropriation for fleet submarines calling for a surface speed of 25 knots. To secure 25 knots will require vessels of probably not less than 300 feet in length, with probably not less than 10,000 horsepower. It will be seen, therefore, that much has yet to be done in the way of development of high-powered engines suitable for submarine vessels of such high speed as 25 knots. There is no difficulty in the way of designing and building a vessel for 25 knots as soon as suitable engines are developed for them.

There are some destructive actions in connection with large, high speed, light weight internal combustion engines that practically all designing engineers have failed to grasp. Otherwise, engineers of all nationalities would not have failed to the extent they have, and I do not believe there is a submarine engine in service to-day that has fully met the expectations of its designers and builders.

It is unfortunate for the engineering profession that government policy will not permit of a full disclosure of the defects of engines and other equipment in government-owned vessels. Were a frank disclosure made, other inventors and engineers would, in all probability, take up the problems, and they might the sooner be solved.

All the earlier submarines were equipped with engines which used gasoline (petrol) as a fuel, but the gas from this fuel when mixed with a proper proportion of air, is

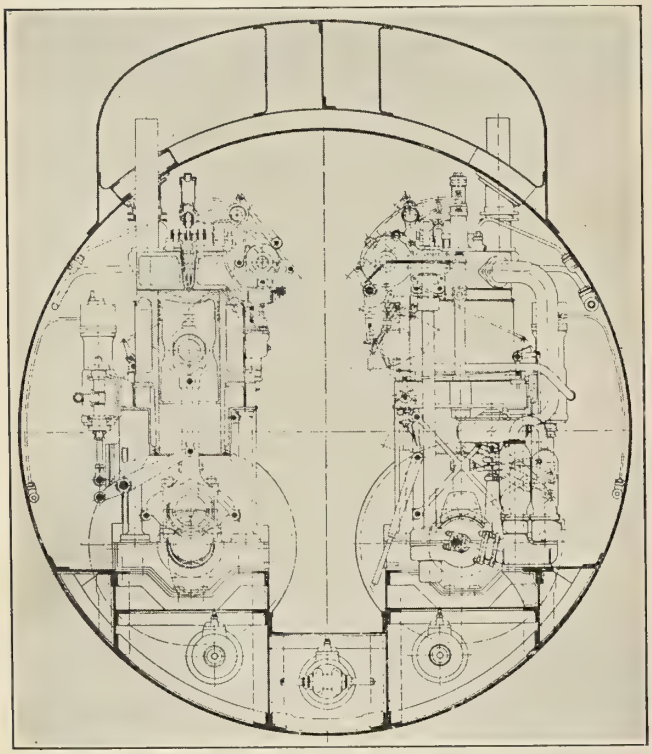


Fig. 35.—End Elevation and Sectional View Through a 200-Horsepower, Four-Cylinder, Four-Cycle Submarine Engine of Krupp Design, Installed in a Submarine Boat

This view is typical of submarine engine installations in submarine boats. Owing to the call for increased speeds, it will be observed that the engines leave very little room for the operators to pass either between or behind them. In many installations it is impossible to pass between the engine and the skin of the ship. It is therefore essential in the designing of a submarine engine that all parts of the engine be readily accessible from the front. The inaccessibility of parts is even more pronounced than is indicated in the above illustration, as the lubricating piping, water circulating piping and many of the minor parts of the engine are not indicated in this illustration.

highly explosive. A number of serious explosions occurred in submarines due to this gas escaping from leaky tanks, pipings or valves. Some of them were accompanied by loss of life. The most disastrous was that on board the Italian submarine *Foca*, in which, it is reported, twenty-three men were killed. Therefore, several years ago, all governments demanded the installation of engines using a non-explosive fuel. All builders then turned to the "Diesel" engine as offering a solution of the problem.

As early as 1905 I had anticipated that such a demand would ultimately be made, so during that year I built (in Berlin, Germany) an experimental double-acting heavy oil engine, but unfortunately the engineer in charge of the work was taken ill and eventually died. This engine was later completed and showed great flexibility in its control and in reversing. It, however, has never been put on a manufacturing basis.

First Diesel Engine for Submarines

In the meantime, others took up the work of developing the heavy oil Diesel engine for submarines. The first of the Diesel type engines to be installed in a submarine were built by a well-known French firm of engine builders. As we were then in the market for heavy oil submarine engines, plans of these engines were submitted to me, but I found it impossible to install them in any boat we then had under construction owing to their size and weight. I have been advised that engines of this design were installed in some of the French submarine boats, and I have also been informed that the shock and vibrations produced by them were such as to cause the rivets in the boats to loosen and start the vessel leaking so that it was found necessary to take them out. These engines differed only slightly from the vertical Diesel land engine. They were of comparatively slow speed, with very heavy flywheels and of the four-cycle type.

The Diesel engine builders then turned their attention to higher speed engines, and several firms brought out engines, both four and two cycle, running at speeds of from 400 to as much as 550 revolutions per minute, with piston speeds of as much as 1,100 feet per minute. Before these engines were built and tested out in actual service, governments began to demand that they be made reversible. This brought about still further complications. Reference to the top of the cylinder heads of one of the best known and most successful of the "Continental" engines, shown on page 453, will give some idea of the complication brought about by this demand for reversibility.

Complicated Mechanism on Cylinder Heads

The engine as shown contains no less than 12 cams per cylinder, a multiplicity of rocking levers, valves, etc., which make the head exceedingly complicated. Another six-cylinder American reversible engine of recent design which contains 4 cam shafts, 78 cams, with their multiplicity of cam wheels, levers, valves, etc., is, if anything, more complicated than the foreign design shown. The writer witnessed the tests of one of these reversible "Continental" engines in a small boat in Europe and in the engine room it sounded as if "pandemonium" had broken loose. This was a high speed engine running at about 450 revolutions per minute. The cams were about 6 inches in diameter, and although they were enclosed in casings, the noise was so great that it was impossible to hear gongs, and consequently sight indicators for the engineer had to be installed. It was absolutely impossible to carry on conversation in the engine room, even though the speaker placed his mouth right up to the listener's ear and shouted as loudly as he could. It was even impossible to carry on conversation on the after deck, and the only place where a conversation could be carried on without shouting was on deck near the bow of the vessel.

The "bearing" pressures have been so high in some of these engines that it is necessary to use forced lubrication at considerable pressures to prevent the bearing seizing. This high bearing pressure the writer believes to be bad practice in engines designed for use in submarine boats. It may have proved satisfactory in destroyers or other high-power boats where there is plenty of room to have a sufficient number of oilers on continuous duty, and where they can "feel" the bearings.

In case of failure of the high-pressure oil lubricating system in a submarine, the engine is likely in a minute to be put out of commission for months. I have known of

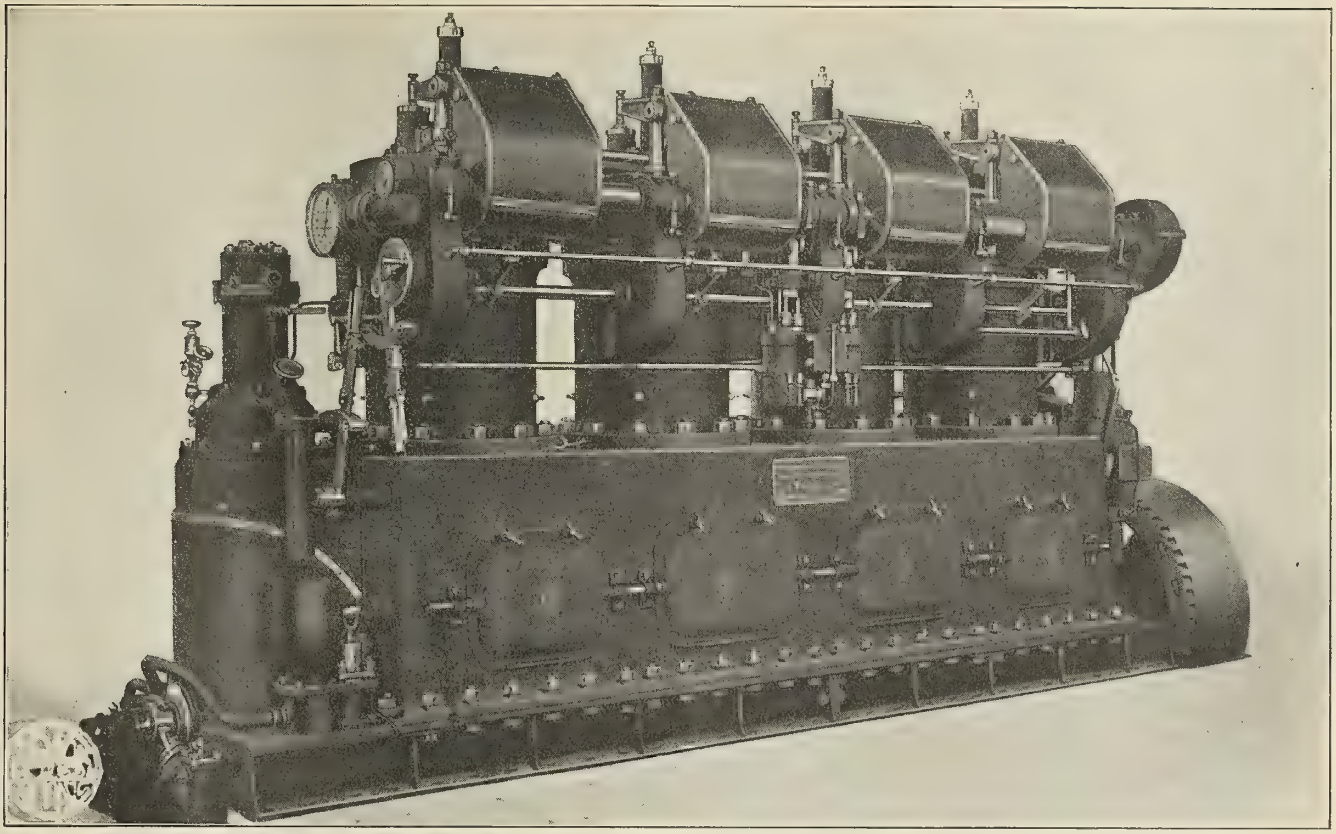


Fig. 36.—Augsburg Type Four-Cylinder, Four-Cycle Engine, as Used on a Number of German Submarines

This engine is said to have stood up very well in actual service. It is heavier per horsepower than some other Diesel engines, and not so complicated; while the four-cycle engine takes up more room than the two-cycle engine per horsepower developed, it is somewhat more economical of fuel and where high speed is not made the first consideration in the design of a boat, the four-cycle engine under the present stage of heavy oil engine development seems to have proved to be the most reliable under long-continued service.

engines being built where the pressures ran up to as much as 1,700 pounds per square inch on the main bearings and crankpins. Further, with these same engines I have known the engine force to work for weeks before they succeeded in getting the oil system to function in a satisfactory manner. Even where maximum explosion pressures have not exceeded 1,200 pounds per square inch, frequent heating of bearings have occurred, and it has been necessary to install water-cooled caps to permit the engines to be run at their designed speed and power.

Safe Bearing Pressure

My experience has taught me that in submarine boats engines should not exceed 1,000 pounds per square inch of projected area on main bearings or crankpins.

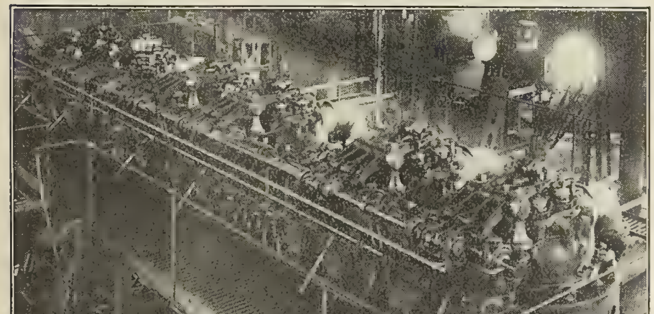


Fig. 37.—Complicated Mechanism on Cylinder Heads of European Reversible Diesel Engine

The great multiplicity of cams, levers, valves and their attachments accounts for the great cost of the Diesel type of engine over the ordinary four-cycle gasoline (petrol) engine. The mechanism has functioned very well on engines running at approximately 100 revolutions per minute, but when the speed is increased to 350 to 400 revolutions per minute, as is necessary in submarine-boat engines in order to get them into the small space available, the noise becomes terrific.

The engine is the most important element in the submarine. Without it, it is impossible to make long surface runs, and with it disabled, it is impossible to charge the storage batteries to enable the submarine to function submerged, which is, of course, what she is built for doing.

I think the demand for increased speed has come too rapidly. It is more important to have reliability than speed. The criticisms which have been made regarding United States submarines, if traced to their source, may be found to be justified as far as they apply to the engines, but the Navy Department cannot be held responsible, and neither can the designers of submarines. They have both searched the world's markets and secured the best that could be purchased. All naval departments were undoubtedly right when they decided to abandon the gasoline (petrol) engine and substitute therefor the heavy oil engine. Eventually a successful heavy oil engine will be produced.

The Diesel engine, weighing practically 500 pounds or more per horsepower, has functioned satisfactorily in land installations, and has come into very general use, especially in Germany, but when the attempt was made to change this slow speed engine of 500 pounds per horsepower, into high speed engines of approximately 50 pounds per horsepower, all designers "fell down." It was but natural that naval authorities throughout the world should call for increased speed, and they cannot be criticised for that, as it is a desirable thing, but experience has shown that they called for it too early "in the game."

The expense of the development of a new type of motive power, such as the high speed, heavy oil-burning engine, for use in vessels whose prime purpose is to preserve the autonomy of the country, should be borne by the govern-

ment rather than individuals or private corporations. Millions of dollars have been expended in the development work of engines and the successful engine is not yet on the market, although vast improvements are now in progress.

Diameter of Crank Shafts

To develop 600 horsepower at 400 revolutions per minute, engine designers a few years ago thought 5-inch crank shafts were ample. When it is taken into consideration that 5-inch crank shafts have been used successfully to transmit 2,000 horsepower on a steam engine running at 400 revolutions per minute, one can understand that the designers of internal combustion engines may have been justified in thinking that they had a sufficient margin of safety in providing a 5-inch crank shaft where engines failed, and a government commission was appointed to investigate the cause of failure. Expert engineers were called in to investigate the matter. The engines had functioned very satisfactorily indeed up to about 300 revolutions per minute. They were designed to give 600 horsepower each at about 375 revolutions per minute. The crank shafts were 4½ inches in diameter. There were twelve cylinders on the shaft. The shaft was the same size all through.

When the design of these engines was under way, the writer suggested that it would be a good idea to increase the diameter of the crank shafts towards the stern, as manifestly the load became greater towards the propeller. The engine builders maintained that the crank shafts were ample in size and guaranteed them to carry the load satis-

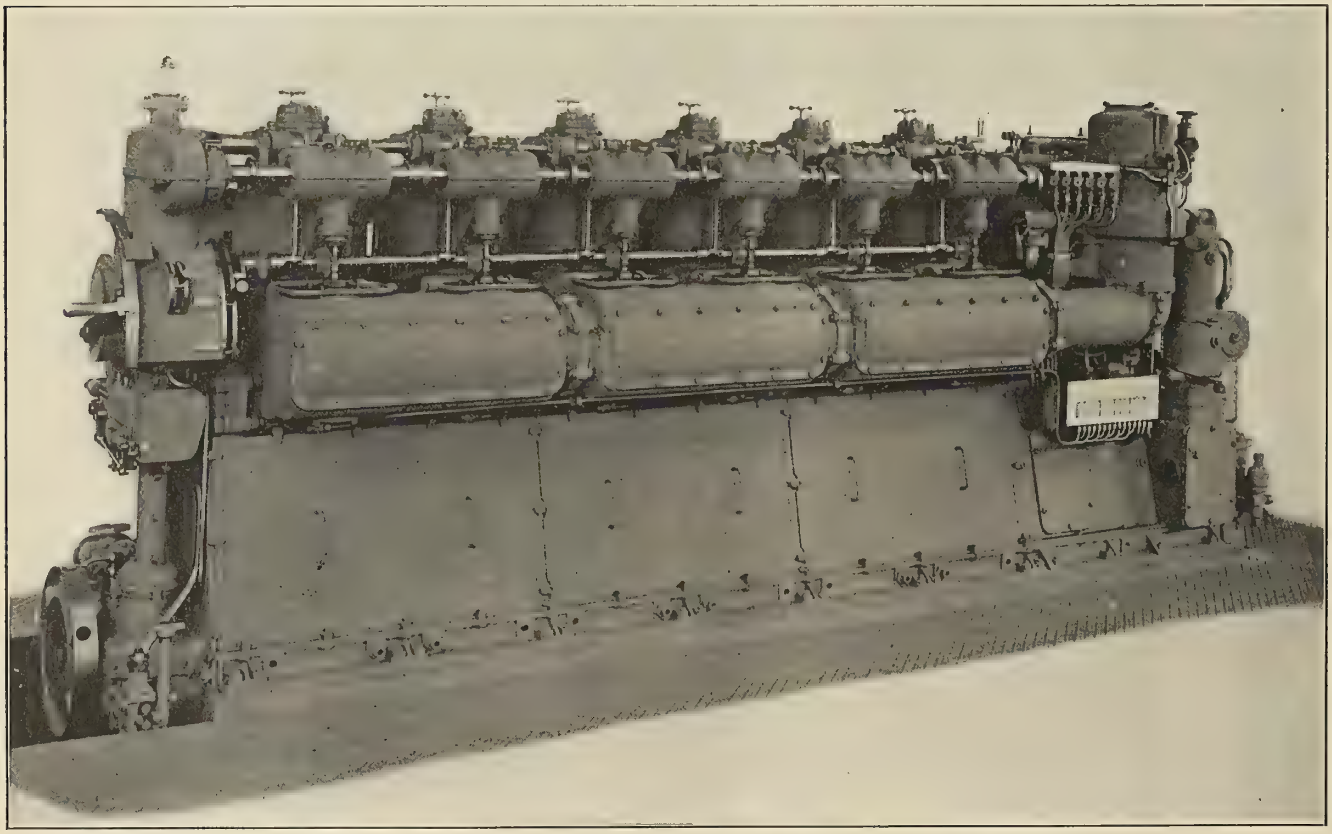


Fig. 38.—Sulzer Diesel Engine Used on Some of the Lake and European Submarines

Messrs. Sulzer Bros. were one of the early engine builders in Europe to take up and develop the Diesel engine, and several thousand men are employed in their works at Winterthur, Switzerland, building these engines. Several years ago they took up the development of an engine for submarine work, and have furnished such engines to European countries and also to the Lake Torpedo Boat Company in the United States. About three years ago a company known as the Busch-Sulzer Bros.-Diesel Engine Company, was formed in the United States to build these engines, and one of the most complete plants of the kind in the world was erected at St. Louis, Mo. Mr. Robert Sulzer is director of this company, and Dr. Diesel was himself a director up until the time of his death. It is believed that the engines now being constructed by this company will overcome many of the difficulties heretofore experienced in submarine engines, as referred to in the text of this article.

for one 600 horsepower internal combustion engine. Experience has shown, however, that this is not sufficient. The reason why it is not sufficient has not been made entirely clear, as, according to all of the best engineering formulas, this margin would seem to be ample, taking the maximum stresses that could be brought to bear upon the shaft, but the fact remains that they have failed. My own opinion is that it is probably due to the heavy armature "close connected" to the engines. This armature weighs in modern submarine boats, several tons. The multiplicity of explosions which produces rapid acceleration with intervals of retardation may produce an effect similar to hammer blows which fatigue the material and cause failure.

I remember one instance in a certain European navy

factorily. The opinion of other engineers was asked, and they also advised that 4½-inch crank shafts were ample to carry the load at the revolutions stated. Consequently the engines were bought and paid for and were installed on board the vessels for which they were ordered.

As previously stated, they worked satisfactorily up to 300 revolutions per minute, but when the time came to test them out under full load, the crank shafts twisted, commencing at the eighth cylinder, counting from forward to aft. After an attempt to run them at full load, the eighth crank was found to be twisted three degrees, with a progressive increase in each crank aft, and the last crank was found to be twisted over 45 degrees.

As these boats worked satisfactorily under all conditions except at full engine speed on the surface, the government

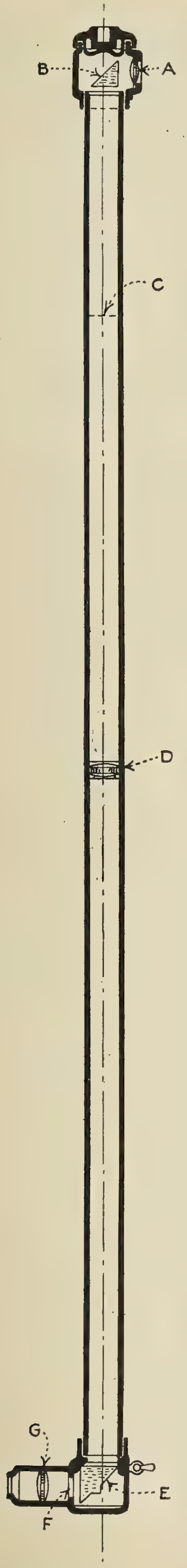


Fig. 39

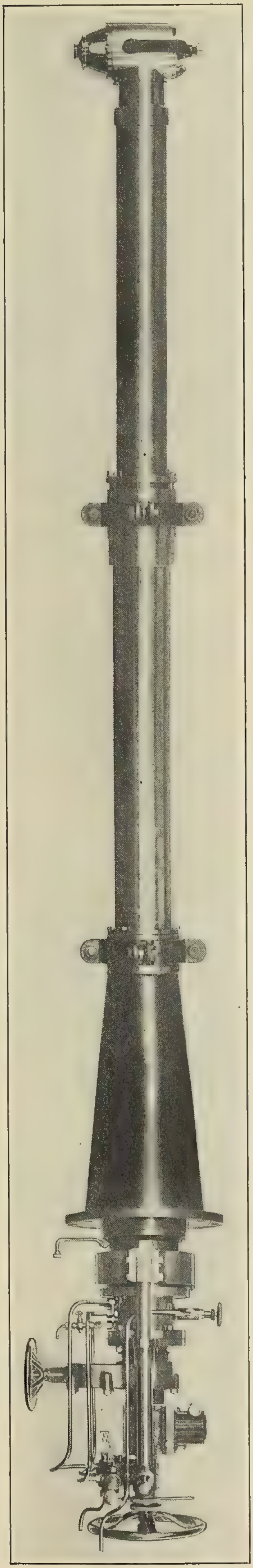


Fig. 40

stated that they would accept the boats, as they wanted to put them in commission at once, and they would themselves put in new crank shafts. These were the same engines for which the writer had recommended larger crank shafts, but not being an engine designer I was overruled.

When these crank shafts failed, the writer again recommended to the Government Commission that they put in larger crank shafts. This Commission took expert advice and held various hearings on the matter. Engineers differed. The ranking engineer on the Commission, after having had pulling tests made of the crank shaft that failed, claimed that the twisting was caused by the use too mild metal, and that if new crank shafts were installed of "Krupp" nickel steel, 4½ inches diameter would be sufficient to carry the load. A young engineer, with rank of lieutenant, on the other hand, claimed the crank shafts should be 6 inches in diameter.

The boats had been running in the meantime under the eight forward cylinders at about 300 revolutions, which gave them about 11½ knots, instead of the fourteen desired. Finally, after several months, the counsel of the

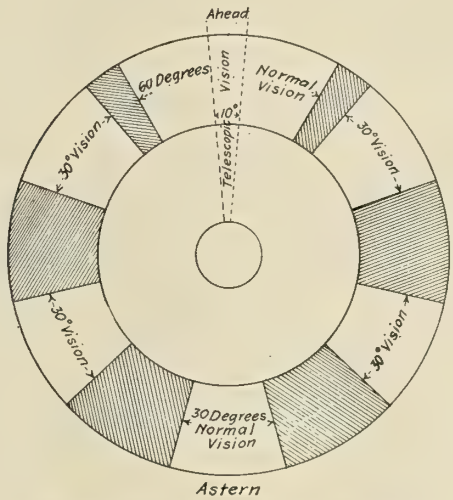


Fig. 41.—Field of Vision of Omniscope

The omniscope is an instrument which is designed to give normal vision covering a field of about 60 degrees ahead. It also gives telescopic vision of a magnification of eight to ten, straight ahead. It may also be arranged to give a complete view of the balance of the horizon at one time, but this cannot be secured and give normal vision at the same time, for the reason that we are accustomed to seeing with the normal eye only about sixty degrees of the horizon at one time. If we bring the entire horizon so that it is viewed at one time we do not get a correct impression as to distance. In other words, if we bring 360 degrees of horizon on to the retina of the eye, an object appearing in this horizon of 360 degrees appears to be much further away, as it is necessarily reduced to 1/6 in size, and we are accustomed to judging distance by the size of the picture which appears upon the retina or photographic plate of the eye. Therefore, the omniscope view is of no value for judging the distance; its only value is to denote the immediate presence in the vicinity of the submarine the instant the head of the omniscope appears above the surface.

senior engineer prevailed, and the government ordered new shafts of nickel steel from Krupp, and which, on attempting to run at full speed, snapped like pipe stems instead of twisting.

Later, engines of equal power were built with 5-inch and still later with 6-inch crank shafts, and in the last 600 horsepower engines that I had to do with I insisted that the crank shafts be made not less than 7 inches, which most engineers say is much heavier than should be required, but experience and unknown stresses made it, from a builders' point of view, advisable to have a surplus of strength rather than a failure, and I believe the general tendency is now to look for reliability rather than speed. This tendency is also manifested in our own government's latest requirements for submarine boat engines, in which they have eliminated the requirement for reversible engines and permit the installation of the simpler form of

non-reversible engine, making it necessary when running under engines on the surface to cut out the engines and reverse under motors.

This seems a step backwards and undoubtedly is a halt in progress, but the department is undoubtedly fully justified, from its experience, in making a temporary "halt" to give the engine designer and builder an opportunity to "catch up," and undoubtedly engine builders throughout the world are making heroic efforts to "make good," but it requires months or years in some cases to bring to perfection a new and satisfactory design of such a complicated device as a reversible high speed, heavy oil engine.

Dr. Diesel has stated that he worked seven years before he succeeded in getting his first engine to make one complete revolution. Governments and the people must, therefore, content themselves to accept what they can get in a heavy oil engine, imperfect though it may be, until such time as a satisfactory engine is evolved, built and tested out under service conditions.

The illustrations accompanying this article, of some of the latest engines turned out by the most important engine builders in the world, will show that great efforts are being made to meet the demands of various governments for a satisfactory high speed, high powered, reversible engine, capable of economically burning non-explosive heavy oils.

Periscopes

The periscope is the eye of the submarine. In its simpler form it consists of a stiff metallic tube from 15 to 20 feet in length and about 4 inches in diameter. Referring to Fig. 39, it is made up of an object glass, *A*, which "views" or takes an "impression of all objects within its range" or "field of vision" and transmits an image of such object through the right angle prism, *B*, which turns the image so that it appears some distance down the tube—say for purposes of description—at *C*. If a field of ground glass were held at the focus of the objective lens *C*, the image could be seen, The lens *D*, located further down the tube, in turn now "views" the image and transmits it still further down the tube, where it is turned through the right angle prism, *E*, and where the image is again turned into an erect position. A piece of ground glass located at *F* would show the image in the same manner as an image is shown on the ground glass of a camera. The magnifying eye piece *G* magnifies the image so that the object appears of natural size.

Fig. 40 shows a periscope as made by the Officina Galileo in Florence, Italy. This firm makes periscopes with binocular eye pieces. The success of any periscope depends upon the character of the material used in the lenses and prisms and the accuracy of the workmanship. This firm, which is probably the oldest optical manufacturing house in the world, said to have been founded by Galileo himself, turns out instruments of the most beautiful workmanship. The flange of the instrument is bolted to the top of the conning tower or deck and a gate valve is arranged between the deck and the eye piece so that in case the tube should be carried away the gate valve can be closed, and thus prevent water from entering the vessel. A hand wheel arranged below the binocular eye piece permits of easy rotation of the instrument. Provision is made for introducing dry air, which prevents condensation forming on the lenses or prisms within the tube.

Owing to the fact that there is a certain loss of light in transmitting the image through the various prisms and lenses, it is customary to magnify the image so that it appears to be about one-quarter above natural size—that is, when viewing the same object through the periscope with one eye and the other with the natural eye, the object viewed through the periscope appears to be about one-quarter larger than when viewed by the natural eye. This has been found by experience to give, when viewed through the periscope alone from a submerged vessel, the impression of correct distance.

Previous to 1900 there was no instrument that would give through a long tube normal vision and a correct idea as to distance. At this time the writer took up with various opticians the question of producing such an instrument. They all contended that it was impossible to produce an instrument that would give through a long tube a field of vision equal to the natural eye or that would convey a correct idea as to the distance of an object when viewed through a long tube. The camera lucidia which Mr. Holland and others had used in the earlier submarines simply threw a picture of the object on a bit of white paper, usually located on a table. This did not give to the observer any more idea of the correct distance of an object than a photograph would. Believing, however, that a solution could be found, the writer purchased a variety of lenses and started making experiments.

Without any special knowledge of optical science, one day quite by accident, I secured the desired result and found that it was possible to secure practically normal vision through a tube of considerable length. About the same time, Sir Howard Grubb, of England, brought out an instrument in which he accomplished the same result. The writer then continued experiments and brought out an instrument which was designed to give a simultaneous view of the entire horizon.

This instrument was called an "omniscope." It was first called a "skalomniscope," which was a word coined with the idea of describing the function of the instrument and which, translated, means "to view and measure everything." A scale was used in connection with this instrument which would convert it into a range finder by measuring the image of an object of known dimensions, such as the length of a ship or the height of its smokestack, and give simultaneous reading as to its distance.

For a time it was necessary for us to manufacture our own sighting instruments, but later, when the optical houses understood the principle of the periscope, they took up the matter of manufacture and have greatly improved them, so that it is now possible to secure instruments of great accuracy and fine definition.

The periscope, however, is faulty, in that it is only an instrument for day use. As soon as dusk comes on the periscope becomes useless. The passing of the image down through the various lenses and prisms reduces the brilliancy of the image to such an extent that, even although it is finely magnified to above normal, the image is so thin that it cannot be seen. This forces the submarine to become vulnerable in making an attack at night, as it is necessary for the conning tower to be brought a sufficient distance above the surface of the water to permit the commanding officer to secure natural vision.

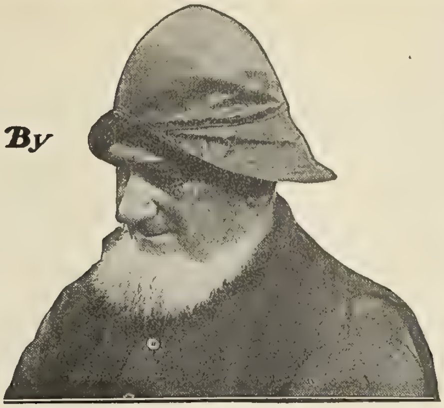
With the powerful searchlights and rapid-fire guns, the submarine would have little opportunity to approach a surface war vessel at night without great danger of being discovered and destroyed.

There is a device which the writer believes, however, can be successfully used for night work, which will be described in a later article.

(*To be continued.*)

The keel of the United States battleship *California* will be laid at the New York Navy Yard, Brooklyn, N. Y., on October 14.

Economy Talks By "Old Scotch"



Some Suggestions About the Use of Zinc

They say that everyone at some time in his life has a chance to get rich, or, in other words, that Fortune knocks at every man's door at least once in his lifetime. Well, the old dame has knocked at every marine engineer's bulkhead door pretty hard more than once in the past year. What's that! You didn't hear her? Well, I didn't, either, but she knocked just the same, and it is my object in this particular issue to show you at least one place where she knocked, and knocked long and loud.

Zinc, you know, is a metal much used in all ships, principally in the boilers and around sea connections. About a year ago you could have bought all the block zinc you wanted for about eight or ten cents (0/4 or 0/5) a pound. If you have had occasion to purchase any recently, you have had to come across at the rate of about thirty to thirty-five cents (1/3 to 1/5½) a pound. If you had had a sufficient "hunch" and filled up a spare bunker with this metal at eight cents (0/4) the pound, you can easily see where you would have been walking along West street right now with your head in the air and whistling "I don't care if I never see the sea again," or some other classic like that.

Just think of it—a metal that we would kick around the fireroom and value it just a little more than burned-out grate bars to take a jump like it has and increase in value over two hundred percent in less than a year! If it keeps on like this, we will be making watchcharms out of it, or perhaps we will have our dentists digging it out of our teeth and substituting gold or platinum, or other cheap metals like those, in its place. They say "you never miss the water until the well runs dry," so if that is so we ought certainly to increase our fondness for zinc at an alarming rate to keep pace with its scarcity.

The object of this screed, however, is to make some suggestions about the use of zinc, so that we will not have to go broke by using it so much on our ships. Every marine engineer is trained up to know that brass or copper in close contact to steel or iron will result in the latter getting the worst of it when they are immersed in salt water. Hence we have all been trained to use goodly quantities of zinc around sea-valve openings in the hull and around propellers when bronze wheels are used, in order to save the iron or steel of the ship's structure. Our old friend—or our old enemy, in this instance—Mr. Electrolysis, gets in his work strong if we do not take the precaution of using zinc liberally on the ship's hull near anything that is made of brass or copper. The daily papers recently contained stories of the almost complete destruction of a half-million-dollar yacht (we will make it half of that sum, to keep near the actual cost) on her maiden voyage from Boston to New York, because due regard was not paid to this precaution.

It seems that the stern, stern post and rudder frame were made of wrought steel, and the yacht was plated with Monel metal, a natural alloy said to contain about sixty percent of nickel and fifty percent of zinc. It is also rumored that the plates were fastened to the frames and to each other with steel rivets. As Monel metal has much of the properties for active galvanic action as are possessed by the bronzes, the inevitable happened and the steel parts of the structure were rapidly disintegrated, causing the untimely scrapping of a very valuable yacht.

Of course, the answer is that the stern, stern frame, etc., should have been made of manganese or other similar bronze with which there would have been little or no galvanic action. It is always easy to see what causes such things after the damage is done, so I am not trying to criticise the designers or builders of this particular vessel. What I am driving at is that if you do not use metals which start up galvanic action it is not necessary to take precautions for preventing it.

This is particularly applicable to sea connections. Formerly it was the universal practice to fit all sea-valves of brass and to use brass strainers, copper injection pipes, etc. Now most of the up-to-date shipbuilders carefully avoid brass or copper around sea connections. Where formerly it was absolutely necessary to fit special zinc rings around all sea-valve openings every time the ship was docked, it is now not necessary, when steel plate strainers are used, and cast iron valves are substituted for brass. Some builders even fit the injection pipe of cast iron, and they work all right, too. I have seen a 10-inch copper main injector pipe renewed after only one year's service, because of holes pitted through it by galvanic action from the spelter which was used in brazing the joints and flanges.

Recently shipbuilders have adopted the expediency of casting a number of vertical ribs around the bodies of valves; and as the effect of the galvanic action does not reach these external ribs, the valve is supported in a cage-like structure, which makes them absolutely safe. At all events, by the elimination of brass and copper we are not compelled to fit the zinc rings around the openings in the hulls, and, "believe me," that saves some little expense when zinc is around thirty-five cents (1/5½) a pound, and threatening to go higher on account of the greed of the warring nations for this valuable munition.

Of course, for the time-being, while the high-brows are scrapping as to the value of different kinds of boiler compound in preventing corrosion and pitting, the prudent engineer will continue to use some zincs in the boilers. It is better to use some of this high-priced zinc than to sacrifice a ten-thousand-dollar (£2,140) boiler for the lack of it.

Yours for economy,

Old Scotch

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Advantages of the Turret Deck Steamer

Q.—What advantage is claimed for a type of steamer often seen in different ports, similar to a whale back, having a narrow deck, the sides flaring out a little above the waterline? What is that type of construction called? C. D.

A.—The vessel you describe is what is known as a turret deck steamer, a type of construction originally brought out and patented by Doxford's in Great Britain, and has been very popular for the past decade for bulk freighters. They

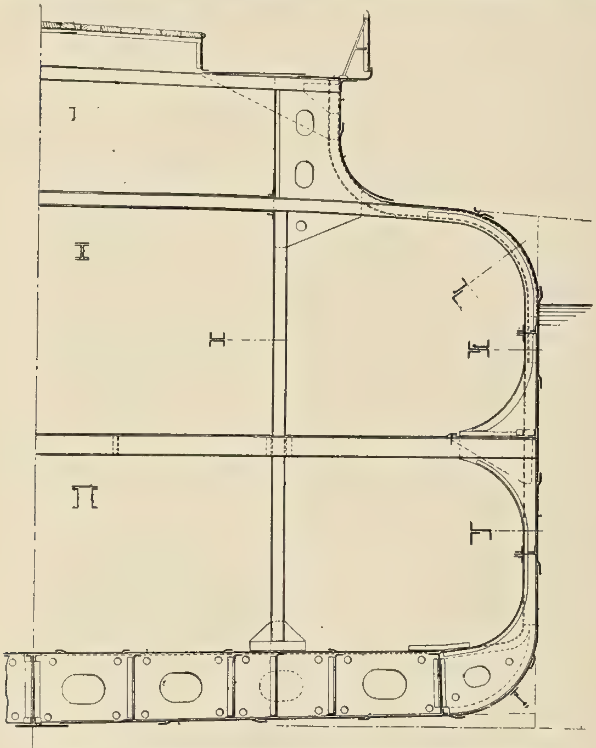


Fig. 1.—Midship Section of Turret Deck Steamer

were originally evolved for bulk carriers when the hold could not be filled entirely full, either on account of stowage or overloading. Cutting away the outboard parts of the upper 'tween decks served the double purpose of reducing the tonnage measurement and consequent port charges and providing a central trunk which served as an expansion chamber and also made the vessels self-trimmers when loaded with a cargo such as grain.

Incidental to these prime reasons were others of a constructive nature which helped keep the type popular, as they were cheap and strong (no sheer, long parallel middle body, etc.). But there are few built at the present time. They are inferior to the standard type in stability when heeled to an excessive angle. A modification of this

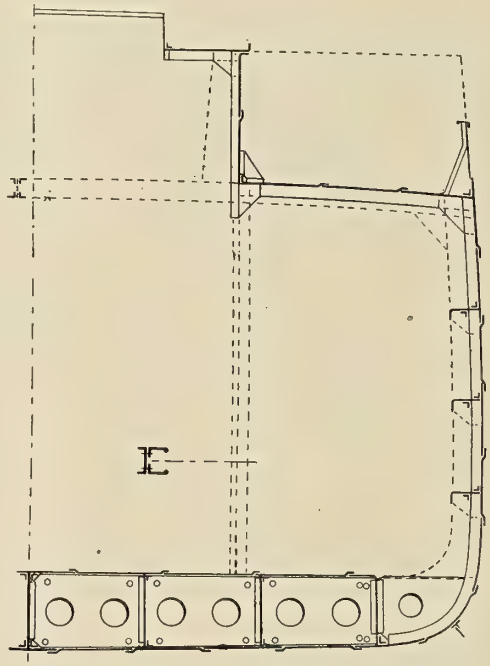


Fig. 2.—Midship Section of Trunk Deck Steamer

type built with square corners is called a trunk deck type. (See sketches.)

Stress and Strain

Q.—Will you kindly distinguish for me the difference in meaning between stress and strain? L. F.

A.—Stress, as defined by Morley, is "the equal and opposite action and reaction which takes place between two bodies or two parts of the same body when transmitting forces." The *intensity of stress* at a surface, generally referred to with less exactness as merely the stress, is the force transmitted per unit of area, in the case of uniform distribution.

Strain is the alteration of shape or dimension resulting from stress, and is measured by the fractional elongation or contraction. In general, we may consider stress as the force and the strain as the distortion which the force produces. It is improper to speak of a strain of so many pounds.

Heating Surface of a Corrugated Furnace

Q.—How do you figure the heating surface of a corrugated furnace of the Morison or Fox type? F.

A.—In estimating the heating surface of a corrugated furnace the makers figure it the same as that of a plain cylindrical furnace whose diameter is equal to the mean diameter of the corrugated furnace.

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Economy

Since the ship *X* has always stood well in engineering, it looked like a hopeless task to improve what had been so consistently good as to have made her generally known as a "star ship." To improve a ship that had been as notoriously bad in engineering could have been undertaken with more hope of success. Kipling described the condition as: "Yon's strain, hard strain, o' head and hand, for though Thy power brings all skill to naught, ye'll understand a man must think o' things."

"Old Scotch" has thought of the many "things," small things, and told them in his "Economy Talks" in INTERNATIONAL MARINE ENGINEERING. The big things had been thought of on the ship *X*, put into effect, and had become an old story, with the result that the plant was in an efficient condition. But that the "Old Scotch economy talks" can help in increasing existing efficiency is shown by the following table of performances:

Year	Knots per ton at 11 knots speed	Tons per hour at anchor	Speed maintained during a four-hour test
1911-12	2.56	.95	18.17
1912-13	2.59	1.08	18.04
1913-14	2.64	.73	18.36
1914-15	3.00	.66	18.44

As far as is known there has been no new scheme used or developed; there has been merely a systematic application of old wrinkles in engineering that have from time to time been published for the information of those "dissolute mechanics" striving to be drivers of engines and Irishmen. We have therefore tabulated what we believe to have been the producers of the above noted results, in the hope that some seafaring brother may have his day's work made easier.

PUMPS

In an inefficient plant the trouble has nearly always been placed at the door of the poor old pumps, so they were tackled first, and in three cases, three auxiliary feed pumps, they were found to run along just as merrily and clamorously with the discharge closed as with it open. These pumps have outside packed plungers which show a leaky plunger at once, and since the plungers were tight this made the trouble unmistakably in the suction and discharge valves.

The bonnets were removed and these valves seemed in good condition, but measurements showed the following: The valve seats (*a*) and (*b*) (Fig. 1) with the valve guards (*c*) (*c*) had been put in place and the nut (*d*) set up before the nut (*c*). Thus (*a* and *b*) were drawn from their seats (*f*) (*f*) and water could flow between (*b*) and (*f*).

The operation was then reversed, (*d*) removed and (*e*) set up; when (*e*) was well home then (*d*) was set up. Before again testing the pump the steam valve was spot faced on a face plate and the piston rings renewed. The tightness of the rings was then tested as follows: With the cylinder head removed the piston was shored from the crosshead to prevent upward motion and a steam hose connected to the lower drain cock of the steam cylinder and pressure raised to the pump's working pressure. A leak around the piston ring was thus easily detected.

The above-mentioned treatment was given to every pump—auxiliary condenser and dynamo circulating pumps included. Thus in all cases the pump piston speed has been reduced below 100 feet per minute.

To maintain this condition each pump is tested once a week by starting it up and then closing the discharge, or by having it build up pressure on a boiler. Also, weekly

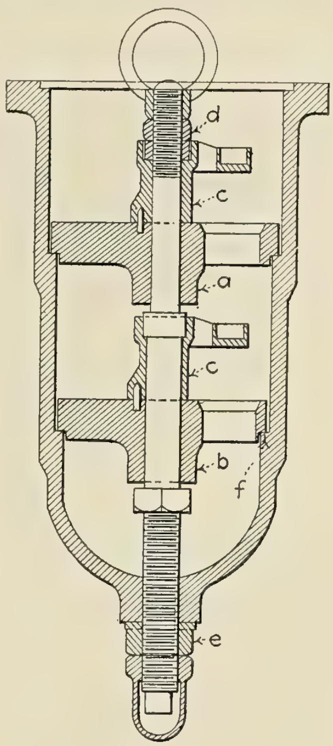


Fig. 1

tests of the tightness of throttle and exhaust valves are made by closing them and opening the cylinder drains. We have been singularly free from pump troubles when prompt service was needed.

TRAPS

The old tried and true test valves were put on all traps and they are tested by means of these valves once each day by an officer. If the test is not satisfactory the trap is cut out at once and the work of examining and repairing is begun, (*a*) and (*b*) (Fig. 2) being closed and (*c*) open while the trap is being tested.

At first some difficulty was experienced in getting the traps so they would operate. This difficulty was overcome by putting monel metal seats and valves in all traps, as shown at (*a*) and (*b*) (Fig. 3). The traps on the ship X are all old. The modern Keilly & Mueller trap is manufactured with valves and seats of monel metal. After the installation of the monel metal the repairs necessary on traps have been remarkably small. The work done on them since July, 1914, is as follows:

October 29, 1914—Trap (Keilly & Mueller) in No. 5 fireroom leaking and valve ground in.

November 11, 1914—Trap (Keilly & Mueller) in No. 4 fireroom leaking and valve ground in.

November 19, 1914—Trap (Keilly & Mueller) to whistle line leaking and valve ground in.

April 24, 1914—Trap (Keilly & Mueller) in No. 2 fireroom leaking and valve ground in.

October 31, 1914—Trap (Keilly & Mueller) on anchor engine line leaking and valve ground in.

December 12, 1914—Traps (Lytton) dynamo line leaking and valve ground in.

February 2, 1915—Trap (Keilly & Mueller) starboard dynamo line renewed valve and seat.

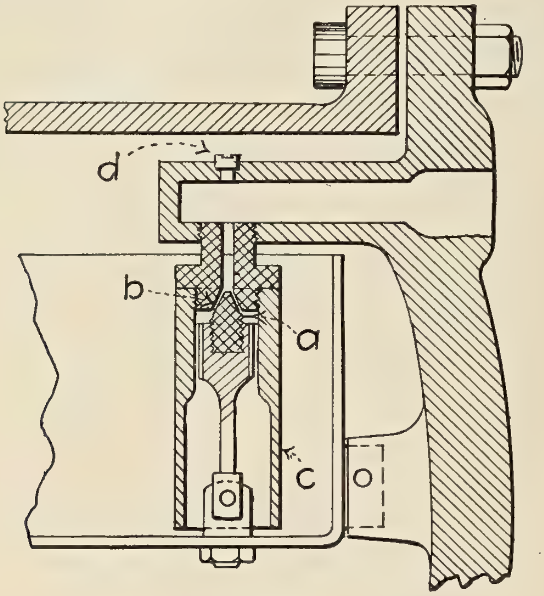


Fig. 2

March 3, 1914—Trap (Keilly & Mueller) in port dynamo line renewed valve and seat.

July 1, 1914—Trap (Keilly & Mueller) both main separators leaking and valves ground in.

August 21, 1914—Trap (Keilly & Mueller) port auxiliary steam line leaking and valves ground in.

When the discharge from a trap is rather prolonged it usually means that the pipe (*c*) is too short. A print was obtained from the Keilly-Mueller Company and fittings made so that in every case the trap conformed to the original drawing.

In two cases it was found that holes had eroded at the point marked (*d*). These holes were drilled and threaded and plugs inserted. This constant watching and care of traps has made them perform the twofold function of preventing live steam from being lost in the drain line and of keeping the steam lines free from water. The result has been practically no loss of water through leaky flanges and stuffing boxes and a great reduction of the work and cost of renewing packing.

Boilers

The water being kept at 4 percent alkalinity or above, is considered to have been the salvation of the Babcock & Wilcox boilers of the ship *X*. The hard, thick scale that infested them was removed with a corresponding reduction in coal consumption. On account of gasket troubles it became necessary to reduce the alkalinity, but periodically the Navy Standard Boiler Compound is used to boil out a boiler. Then all of the tubes are wire brushed and all gaskets are renewed.

The cleaning of the fire side of a Babcock & Wilcox boiler has been a great problem. The use of the air lance was soon found to come under the category of "a lick and a promise," so the chain method of cleaning was adopted. The water tenders were won over to the chain method by permitting them to blow tubes by the usual air lance method, a light was then held on one side of the boiler and they were directed to look between the tubes from the opposite side of the boiler; not a ray of light could be seen. The chain method was then used and the light test repeated, revealing the passages unobstructed, the tubes clean, and the ash pans containing about eight buckets of soot and dirt.

The chain method of cleaning is used after each run.

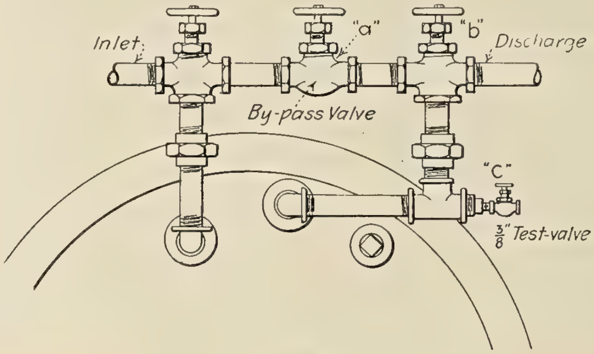


Fig. 3

This method, with the method of rectifying vertical and diagonal baffles, is given below. (See Fig. 4.)

(a) Remove all side doors, grate bars and the baffle brick on the 4-inch tubes that form the horizontal baffle over the forward part of the furnace. The brick removal is necessary for baffle work but not for cleaning.

(b) Clean the boiler thoroughly by hauling a chain back and forth between each row of tubes. This chain should have chain pendants 3 inches long attached to it at intervals of 4 inches throughout its length. The pendants drop down between the tubes and remove the soot lodged on the sides of the tubes. After the chain cleaning is completed the boilers should be blown with compressed air while the blowers are running. The object of this cleaning is so that the dirt and soot will not obstruct the men in their work by dropping into their eyes.

(c) Provide eight iron bars, ¼ inch by 3 inches, for each boiler. The position bars are to be long enough to project from 1 inch above the upper row of 2-inch tubes to 1 inch below the bottom row of 2-inch tubes. Insert these position bars vertically between the tubes from the furnace side, and abaft the baffle the position of which they are to locate. Two of the bars should be placed near the place where the baffles butt in the center of the boiler and the others at about half of the distance to the sides of the boiler. The bars are then clamped in position so that one edge marks the plane that the baffles should form. The position of the edge of the bar is located by taking the distance from the headers to the baffle plane and laying this off on the upper and lower 2-inch tubes. The bottom edge of the bar should be notched so as to form a rest on the bottom clamp to keep the bar from slipping down. The clamps for the bars should be made of ⅜-inch iron at least 2 inches wide. The position bar clamped in place is shown at *A* (Fig. 4). With the position of the baffle thus located the plates that are out of position can be detected by throwing the light from an electric torch on the position bars. This is done by observing from the side doors. If a space is noticed between the position bar and the baffle it will show the baffle to be out of place and leaking.

(d) For forcing the baffles back into place three or more driving bars, shown at *B*, similar to the position bars above described, are provided. These driving bars should be long enough to reach from 6 inches above the upper row of 2-inch tubes to 1 foot below the lower 4-inch tubes. The driving bars are inserted in front of the baffles and clamps are made for them similar to the clamps described above and shown in Fig. 4.

So as not to break the plates that may be frozen to the tubes a preventer bar, marked *C*, is inserted on the horizontal, between the row of tubes where the baffle is out of place and between the plate and the driving bar. The idea of this preventer bar is the same as the use of a large timber on the corner of a dock when warping a vessel into dock. It will be found that the bar is not necessary for every plate, since some of them will go into place with the application of very little pressure.

The baffles are eased back into place until they touch the position bars. This is done by setting up on the top clamp of the driving bar *B*, and bringing pressure to bear on the lower end by means of a sledge, jack or wedges, then the operation is reversed—that is, the lower clamp, shown at *E*, is set up on and pressure applied to the upper end of the driving bar. By taking the tension easily on the three driving bars and by the use of the preventer bar, there is small likelihood of breaking any of the plates in getting them back into position.

(e) When the baffles are in alinement the driving bars and clamps used with them may be removed, but additional position bars should be put in front of the baffles to keep them in position. It is especially important that two of the bars should be placed near the ends of the plates, since the plates are most apt to separate at the place where the ends are supposed to butt.

(f) For holding the diagonal baffle down to the forward vertical baffle the following method has been found to give good results:

Brace a jack against the boiler drum and force the baffle down into position. After the baffle is in position a T-brace is put down between the tubes and turned so that the arms take on the bottom of the tubes; this is then placed against the vertical baffle and a hole drilled through the three—T-brace, vertical baffle and diagonal baffle. A bolt is then inserted and the nut set up on. This is shown at *F* and *G*. Four T-braces to each boiler have given good results.

The boiler plant of ship *X* consists of twelve Babcock & Wilcox thirty-header boilers. Until the completion of the above described baffle repairs it had been necessary to use two boilers for use in port at an average coal consumption of 24.2 tons per day. Since the completion of the repairs described one boiler has been found sufficient to supply all demands in port at an average coal consumption of 16.8 tons per day, or a reduction of 30 percent in the daily coal consumption.

For a time much trouble was encountered with chlorine in the boilers. Repeated tests showed the condensers to be tight. Then close observation and many tests showed that when water was run back from a boiler to the feed tank or to a reserve tank the water in the steaming boilers mounted in chlorinity. The bottom blow pipes were broken at the valves to overboard discharges at the sea stools. In each case these valves were found to be leaking, and that repairs to them could be safely made only when the ship was in dry dock. The old practice of blowing down boilers having gone out of vogue, the pipes and valves were blanked off, giving immediate relief from the salt troubles.

A bucket of powdered asbestos cement is kept in each steaming fireroom, and once each day the casings of the steaming boilers are tested for air leaks with a lighted candle, and leaks stopped.

After the completion of the above noted work on boilers two copper boilers were borrowed from the Landing Force Commissary Equipment and a boiler evaporative test conducted. This test was followed by a dynamo test and a test of the water consumption of auxiliary machinery with the results here noted.

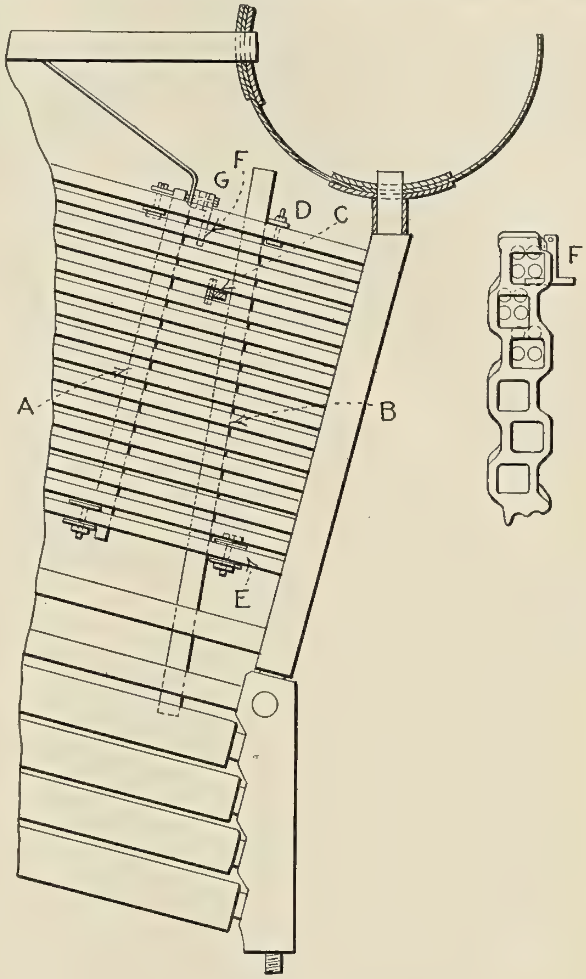


Fig. 4

Test Made on Babcock & Wilcox Boiler No. 7 of the Ship X to Determine Evaporative Efficiency

Kind of Coal.—Pocohontas, semi-bituminous coal.
Kind of Furnace.—Babcock & Wilcox six-door, thirty-header boiler.
Method of Starting and Stopping the Test.—Flying.
Grate Surface.—111.83 square feet.
Water Heating Surface.—4,698 square feet.
Superheating Surface.—None.

Total Quantities

1. Date ....May 25-26, 1914
2. Duration of trial....................24 hours
2. Weight of coal as fired....................37,270.5 pounds
4. Percentage of moisture in coal....................1.07 percent
5. Total weight of dry coal consumed....................36,871.7 pounds
6. Total ash and refuse....................1,823 pounds
7. Percentage of ash and refuse to dry coal....................4.94 percent
8. Total weight of water fed to boiler....................334,837 pounds
9. Factor of evaporation $\frac{1{,}198.75 - 196.5}{965.7}$ 1.038
10. Equivalent evaporation into dry steam....................347,560.8 pounds

Hourly Quantities

11. Dry coal consumed per hour....................1,536.3 pounds

12. Dry coal per square foot of grate surface per hour, 13.738 pounds
13. Water evaporated per hour..............13,951.5 pounds
14. Equivalent evaporation from 212 degrees...14,481.7 pounds
15. Equivalent evaporation from 212 degrees per square foot heating surface per hour............3.082 pounds
16. Steam pressure by gage.....................188.8 pounds
17. Temperature of feed water entering boiler....227.4 degrees
18. Draft in inches water...........................natural

Economic Results

19. Water apparently evaporated under actual conditions per pound of coal as fired..............8.984 pounds
20. Equivalent evaporation from and at 212 degrees as per pound of coal fired.....................9.325 pounds
21. Equivalent evaporation from and at 212 degrees per pound of dry coal.......................9.426 pounds
22. Equivalent evaporation from and at 212 degrees per pound of combustible...................9.916 pounds

Efficiency

23. Calorific value of dry coal per pound.......14,100 B. T. U.
24. Calorific value of combustible per pound....14,750 B. T. U.
25. Efficiency of boiler based on combustible....64.92 percent
26. Efficiency of boiler based on dry coal........64.55 percent

The dynamo and auxiliary machinery tests gave the following results:

Auxiliary machinery in use for 24 hours	111,000
2,200 K. W. H. at 48.1 pounds water per K. W. H.	110,630
12,000 gallons fresh water distilled at 5 pounds per gallon	60,000
Total	281,630 Pounds of water per day

With this data tables were made out for the coal consumption of each piece of machinery for one hour at a given speed. This made it possible to charge each machine with the coal that it had used, then by taking the time that each machine had been in operation during the day and applying to it its cost in coal a list of consumption is obtained the sum of which gives a very good check on the amount of coal that should have been burned in the boilers for any given day. If a large discrepancy creeps in, it shows at once that either error or inefficiency are present and a search can at once be instituted. This further makes it possible to obtain the interest and co-operation of the users of power in reducing coal consumption by being able to keep constantly before their minds the amount of coal that they are expending. For instance, that delaying to give orders to secure a deck pump because it is going to be needed again in two or three hours means throwing away 60 pounds of coal per hour, or in the case of air compressors, 200 pounds of coal per hour.

After a short time a fair average consumption for each department was obtained and continued returns above the average show an excessive use of power in that department. It is then easy to trace out and rectify this lack of supervision and reduce the consumption to normal. Thus each man knows that there is always a check on him. The water tender on watch is credited with the consumption of the various machines in operation during his watch and charged with the amount of coal that he has had to burn. If the accounts do not nearly balance, searches for the leak are begun.

As an illustration of the above the following is given: (Before the effects of the "small things in economy" were begun to be felt, the only date on which one boiler was used for port consumption was on September 3, 1913; the writing of this letter happens to have begun on February 14, 1915; hence the choice of the performances on those two dates for illustrations):

September 3, 1913		Coal
Steam to galley		1.00
Coal to steam launches		2.70
Making 8,000 gallons of fresh water		2.00
Electricity—2,600 K. W. H.		6.22
Auxiliary machinery	Pounds water	
Ice machine	16,900	
Main feed pump	12,792	
Flushing pump	12,504	
Fire and bilge pump	1,273	
Auxiliary condenser	12,090	
Air compressor	931	
	56,490	2.80
Coal allowed		14.72
Coal used		18.20
Coal wasted		3.58

February 14, 1915		Coal
Steam to galley		1.00
Coal to galley		.60
Coal to steam launches		1.30
Making 15,600 gallons of fresh water		3.90
Electricity—1,900 K. W. H.		4.60
Auxiliary machinery	Pounds water	
Ice machine	15,600	
Main feed pump	12,792	
Flushing pump	12,504	
Fire and bilge pump	8,274	
Auxiliary condenser	9,672	
Ash hoisting engine	930	
	59,772	3.00
Coal allowed		14.40
Coal used		14.00
Coal saved		0.40

The allowed consumption in each case being practically the same, the saving may be taken as approximately four tons.

Heating System

It was found that about 10 pounds pressure was required on the heating systems to pantries and warming tables, and that when the evaporators were running the pressure on the drain line would mount to twenty-five pounds if the drains to the tanks were closed. It was then worked out as a good plan to use this heat in the pantries instead of discharging it into a condenser. This was done, the drains finally reached the tanks much lowered in temperature, and satisfaction was maintained among the stewards.

A further connection was made to the heating manifolds and enough heat thus obtained for all officers' quarters when the temperature of the outside air is not below 35 degrees.

Exhaust Steam

The back pressure on the exhaust line is usually carried at about 13 pounds to supply heat to feed water heaters. At first this gave considerable trouble in producing water hammers in the line, which on three occasions ruptured the pipe. This was remedied by installing two drain lines, one in each engine room, from pockets abaft the feed heaters. These lines seemed to relieve the hammering and at the same time increased the temperature of the water in the feed tanks to which they were given a direct lead.

In each fireman's wash room there is a steam jet used for heating water. The line to these jets was connected to the auxiliary exhaust line, thus having heat always available for the firemen in sufficient quantity for their satisfaction and at a cost much less than of live steam.

There was a convenient valve for making a connection for using exhaust steam for warming up the main engines. This connection was made and has proven to be very valuable in warming up the main engines without cost. This is particularly noticeable when operating on the drill grounds where "stand by" orders are very frequent.

The attempt has been made to use all of the heat that leaves the boiler in the steam without having any of it dissipated in the condenser. Water only is wanted back from the system and that can be made to serve a better purpose by being sent directly to the feed tank to expend all of its heat in raising the temperature of the feed water than by having it first cooled off in a condenser.

Comparative speeds of the circulating pump of the auxiliary condenser are given below:

	September 3-13	February 14-15
Strokes per minute	24	18
Piston speed, feet per minute	48	36
Back pressure on auxiliary exhaust	21 pounds	28 pounds
Temperature of feed water	205 degrees	224 degrees
Temperature of feed tank	114 degrees	134 degrees
Temperature of injection	78 degrees	74 degrees
Vacuum	18 inches	24 inches
Steam pressure maintained	184 pounds	215 pounds

Ice Machine

Although the 3-ton Allen dense air ice machine had been giving satisfactory results, it was thought that a small amount of coal might be saved by testing it, so indicator cards were taken on both the steam and expander cylinders.

The cards obtained showed one end of the expander cylinder developing 10.4 indicated horsepower and the other end 7.5 indicated horsepower. A valve adjustment gave eight indicated horsepower on each end and a noticeable difference in the running of the machine as to speed, noise and temperature of the cold storage.

The averages for the weeks of which September 3, 1913, and February 14, 1915, each formed a part are here given:

	September 3-13	February 14-15
Revolutions per minute	67.7	60.0
Compressor pressure	241.0	240.0
Expander pressure	65.7	68.0
Temperature of cold storage, minimum	18.4	10.7
Temperature of cold storage, maximum	43.5	25.0
Injection temperature	77.4	75.0
Piston speed, feet per minute	158.0	140.0

Firing

The time firing device is used at all times, the interval between charges being such as will supply the steam demanded. This interval may vary from one to six minutes.

The routine of cleaning fires at regular intervals has been abandoned. When clinkers form they are removed. We made one run of eight days without going through the old-fashioned "clean two fires each watch," and found the "knots per ton" at the end of the run as good as at the beginning.

In tracing back the causes for increased coal consumption it has rarely been found that the firemen were at fault, but their actions have frequently been used as a gage. When the firemen were noticed hustling around slamming down slice bars and shovels and yelling at the coal passers to rustle out more coal, it was at once known that something was wrong, and when the trouble was located it was pretty certain not to be in the fireroom.

U. S. S. *Nebraska*. Lieut. F. H. Sadler, U. S. N.

More About Economy

Some time ago "Old Scotch," in his very enjoyable and instructive remarks, told about getting along with very little oil when one had to, and he commented on the waste of oil in general. This brought to mind what I am going to tell you about.

Having been in the past a good deal of a wanderer, I have had many bosses, all of whom had the idea of economy constantly in mind, but their economy was always of the spotted variety. One man was death on saving oil; another was hotfoot after coal saving, while a third would go wild if you broke a manhole gasket or used an ounce too much waste; but they all agreed on one point of economy, and that was my salary—on this they were a unit.

Four of us engineers were in charge of four small boats which for a part of the year ran a very few trips daily, but during the rest of the year it was hustle from five in the morning up to nine or ten o'clock at night; so we and the firemen thought we ought to have a little more pay, and asked for it and got "no" for an answer. Just as the slack time came on we were notified that our superintendent had resigned and a Mr. Benson was to take his place, and that Mr. Benson wanted to see us the next Sunday morning at his office, which was on the dock at the end of our run. The offices were up-stairs and the passenger and freight rooms below, with a room fitted up with a lathe, shaper, drill press and emory wheel. These tools, however, had never been used to any great extent.

Mr. Benson began his conversation by handing each of us a cigar. He was a small man, about fifty-five years old, and had gray hair and gray eyes with small crow's-feet in the corners—a sure sign of good nature, but also a warning not to get too fresh. Mr. Benson continued his conversation by saying: "Upon looking over the records I find that you men have asked for more pay. I know what your work is and how you do it, and I think you should have what you ask for; so I asked the directors to let me lift you a little, but they declined. I had looked over the records and knew what the average cost had been the last three years for coal, oil, gaskets, etc.; also what it had cost to overhaul each one of the boats, so I put it up to the board to allow me the average of these costs for next year, and if I could effect any saving that saving would be divided between you and the firemen.

"After some talk they agreed to allow the last three years' average of these expenditures of upkeep and running, less 10 percent, and anything that could be saved should be divided between you and the firemen, you taking 60 percent, the firemen getting 40 percent. I knew you men had all learned the machinist's trade, and, with a little shop downstairs you could make all the repairs necessary to the engines. As the hull repairs amount to very little, they cut no figure, anyway, so I only counted on the motive power for repairs.

"During the slack months we could lay up two boats at a time, and I am sure that by looking after things more carefully than you have done, and will have to do, you can make a saving worth while. What do you think?"

We talked it over and agreed to the idea. Then Mr. Benson went over to his desk and brought back an oil cup. He unscrewed the cover and, taking a toothpick from his pocket, shoved it into the hole in the stem.

"Now, you notice," said he, "that this hole does not go through into the cup. You could fill that cup with oil and put it up on that shelf and it would stay full for all time. Now, here is a little boss cast inside the cup, running up part way, and in that boss you see a little drilled hole. This runs down and meets another hole that is drilled in the bottom of the cup, which in turn meets the hole in the stem. Just above this small hole in the boss you will notice this spoon-shaped piece.

"The cup is good only where there is a reciprocating movement. The idea of it is that you fill the cup to the top of the boss only; when the cup is not moving the oil will not feed, but every time that the cup goes round with the crankpin or up and down on the crosshead the oil is thrown on the top of the boss and feeds down the small hole to the bearing. That hole is mighty small, and I know by the way you men look that you do not believe that enough oil will get down that hole to oil the crankpin of a one-'mouse power' engine, but I will put it on and show you that it will."

And he did. Now, that hole was made with about a No. 60 twist drill. We went right downstairs and put four of these cups on my engine, it being a compound. I took off the sight-feed drip cups and I measured up what one of them would hold, and found that the new cups held a little bit more. We used to fill the old cups twice on a round trip.

Next morning I found Mr. Benson in the engine room

when I got down, and also one of the engineers. I felt pretty nervous, for I was sure that that dinky little hole wouldn't feed oil, and that I would have to overhaul the crosshead pin and brasses when I got back.

Our first stop was about five miles off, and when we made it there was nothing hot. Our next stop was about the same distance, and here we stopped half an hour where I had usually filled my oil cups, so I unscrewed the top of one of the new oil cups with the idea of refilling it, but I give you my word, Mr. Reader, that there was hardly any of the oil gone out of it. So I told Mr. Benson that the cup could not be feeding. He laughed and told me to screw the cap on again. Pretty soon off we went to our starting point. I unscrewed the cap a second time, and the cup was still three-quarters full. We put the cups on all the other boats, and since that time I have put the cups on a number of engines.

If I remember rightly, the man who made these cups was named Bangs. I never knew where his office was, and I do not know whether the cups are now to be found in the market, but I do remember that they were awfully expensive for first cost, a half-pint cup costing something like $16 (3/6/3). Perhaps some of the readers of International Marine Engineering have used these cups, and it would be interesting to hear from them.

The scheme proposed by Mr. Benson worked out satisfactorily to us all.

Yours for economy,

New York. Jack.

Organization of an Engineering Reserve for the Navy

Two articles appearing in a recent issue of the *Journal of the Society of Naval Engineers,* entitled "Organization of the Engineer Division on Board a Man-o'-War" and "Engineer Department of Naval Vessels," are strong appeals for "scientific management" in the engineering departments of our naval vessels. When engineering methods and routine are standardized, we surely will have a far more efficient engineering department in our navy. Such efficiency must be worked out and maintained by the officers and men in active service.

There never will come a time when it can be said of any organization that a state of perfection has been reached. The officers and men of any organization must never have the satisfied feeling of having attained perfection. As soon as this spirit is manifest in any organization it is a sure sign of decay.

In maintaining high standards of efficiency the purpose of the organization must always be kept before the members. Therefore, let us ask "What is the purpose of the engineering department of the navy?" In brief, the answer is "To make our navy an efficient fighting unit for the protection of the nation."

When the real test—war—is put to any military organization, efficiency demands that every fighting machine be fully manned by men familiar with their duties. It is hardly ever practical or desirable that all the men necessary to full fighting efficiency be carried in active service. It is necessary, therefore, to have an efficient reserve. It is the purpose of this article to suggest such a reserve for the engineering department of our navy.

The most valuable men in this reserve would be those who had at some time served in the engineering department of naval vessels. Such men should be listed and classified, and should form the backbone of the reserve. Having done this, the different groups should be formed. The man to be in charge of each group should be designated and given a list of ex-navy men in his group. These ex-regulars would form the nucleus of each group, but not necessarily the total number of the group.

In estimating the number necessary for an ample reserve, the following points would have to be kept in mind: (1) The existing shortages of men; (2) the probable vacancies that would occur during a state of war; (3) the number of vacancies occurring each year due to additional ships, etc.; (4) the number of vacancies occuring from all other causes, such as death, disability, etc. With this information carefully worked out, it would be possible to arrive at the number of men that should be carried in reserve.

The groups should be formed, the headquarters of each group being designated. The one in charge of each group should be furnished with a list of the ex-regulars assigned to his group, and the number necessary to make his complement full. If the number of regulars falls short of his full complement he must at once take steps to fill out his command by enlisting more men.

The enlistment term should be for the same length of time as men in the active service. When once a man has joined the reserve the discipline should be such that the serious purposes of the organization will be fully realized.

The meetings should be regular and all members should be required to be present at each meeting. At these meetings the men should be drilled and instructed in their duties according to their ratings.

The Navy Department should be kept in close touch with each group through those in command. The reserves should be kept informed of the latest methods and practices, etc., of the active service; and if possible given opportunities to take short cruises on board regular ships of the line.

When the members of the reserve organization are actually doing active duty, either on a practice cruise or in an emergency, they should receive the regular pay and allowances according to rank or rating the same as the men on the active list. Places of meeting throughout the year should be provided without expense to the members of the organization and incidental expenses should be provided by the Government. The members should also be provided, without cost, with drill manuals, copies of fleet regulations and all orders, general and special, issued by the Navy Department. In short, everything possible should be done to keep the reservists in as close touch as possible with the regular service.

The advantages of such a reserve worked out in detail along the lines mentioned cannot be overestimated. In the event it should be necessary to call for more men, in time of war, preparatory orders could be issued to those in command of all the reserve groups. There would be no confusion; the men would assemble quietly and hold themselves in readiness. They would know their stations and general duties. In fact, if the organization has been carefully worked out each man's duties would be clearly mapped out.

Compare this method to that of getting the men at the last minute. Picture the confusion resulting from a general rush to places of enlistment! Think of the mass of raw material that would have to be drilled and organized and weeded out! The national crisis could be such that every day lost would be so costly that months of fighting would be necessary to gain the advantage.

Let us never lose sight of the fact that our navy is a fighting machine, organized for the protection of the nation. The time to work out and perfect the smallest details in the organization of the engineering department of the navy is in time of peace. It behooves every thinking man to think, and think hard, make suggestions, and give his services if required.

St. Louis, Mo. Arthur C. Meyers.

Marine Articles in the Engineering Press

Stability Calculations and Experiments on Stability—Investigations of the Propeller Stream—Shipbuilding Contracts

Model Experiments for Stability of Motion of Submarine Boats.—The article deals with model experiments for determining the factors for stability of motion of submarine boats. It is shown that a certain force of reaction, varying with the longitudinal inclinations, will manifest itself ultimately by a depressing force and a tipping moment. To establish stability of motion this latter moment has to be controlled and counteracted by the after horizontal rudders. A description is given of the apparatus at the tank, which, by sliding rods and indicators, gave the resulting reactions for inclinations up to 4 degrees forward. The gradually advancing position of the reaction force is shown to indicate the relatively desirable amount of trim ballast and the point of coincidence of C. G. and reaction—in the investigated case at about 1½ degrees forward inclination—which requires no action of after rudders for stability of motion. It is concluded that by such model experiments it would be possible to closely predetermine the most desirable form of hull and appendages. 11 illustrations. 2,550 words.—*Schiffbau,* February 10.

The Form of the Propeller Stream and Its Energy Changes.—The energy in the stream thrown aft by a ship's propeller is lost for the ship, but is of importance in its dissipation for the surrounding canal banks. The author points out that the investigations in the German government tank have shown that the erosions of canal bottoms were nearly exclusively due to the influence of the screws and not the hulls of passing vessels. Experiments are recorded where measurements by Pitot tubes over the entire disk area of the propeller were made for the changing velocities of the streams, fully aware of the deflecting influence by the rotation of the screw. Three arrangements are described: screw alone with board cover, screw on ship without rudder, and screw on ship with rudder with seven stations increasingly distant from the propeller. High and low foci are found to occur, gradually spreading from the central disk to a much larger flat oval with a twisting pitch of about 37 degrees of these high and low speed spots. An important conclusion is drawn by the author from the curves of the third case of the ship fitted with rudder. Here curves of stream lines of considerable speed are deflected toward the bottom of the canal with pronounced eroding effect. In the first two cases without rudder the lines of any perceptible speed rise and spread out near the surface of the water, leaving the bottom practically intact. 22 illustrations, 2 tables. 2,060 words.—*Zeitschrift Vereines des Deutscher Ingenieure,* July 24.

Experimental Methods at the German Government Tank, Berlin.—(Fifth chapter.) In this chapter the author gives the manner of conducting trials of hydroplanes with water as well as air propellers. To realize a close approximation of the actual trim and lift condition of the hydroplane hull the supporting connections of the model to the traveling carriage of the tank are described as made in flexible and fully balanced form, allowing even for the upward component of the propeller thrust. From the recorded resistance and horsepower curves at different speeds it is shown that a suitable propeller can be selected in the manner previously mentioned; note is taken also of the Admiralty coefficient, which in this class of boats is rising in a remarkable manner with increasing speed. It is stated by the author that the change from water propeller to air propeller still leaves the problem quite well defined, as the propellers, apparently so widely differing, still have almost completely the same efficiencies at corresponding slips and allowance only has to be made for the different densities of the media. It is pointed out that the nominal slip is not of the same value as a recording basis for air propellers, and the practice at the tank employs a function of speed divided by revolutions by diameter as the basis for record. Upon a numerical example the different successive slips are given for determination of the necessary horsepower that with an air propeller will drive a certain hydroplane at a certain speed. 11 illustrations. 2,000 words.—*Schiffbau,* July 28.

On the Execution of Stability Calculations.—This article takes note of the fact that so far stability calculations have been considered satisfactory if they found the horizontal righting arms for a number of single conditions which offered, however, no check control on accuracy. The author mentions an inter-relation between the statical righting arm curve and the dynamical way curve found from the vertically measured positions of the varying centers of buoyancy, which enables the calculator to obtain such a check, although frequently with disappointing results regarding their agreement. The plea is made that the methods in the execution should be more closely watched for inaccuracies. It is pointed out that sectional area curves and moment curves are often so irregular that numerical methods like Simpson's or Tchebycheff's give rather misleading results, due to erratic knuckles of the inclined planes. The employment of a planimeter or integrator is therefore considered the very essence of accuracy from curves, as necessarily drawn up for each inclination. The author considers this method so trustworthy that he shows it calculated on an example for the horizontal position, as well as with a full new set of curves for the vertical position of the center of buoyancy. The method is pronounced also desirable for determining the value of the curve of cubes of the half ordinates in the determination of the metacentric radius of upright conditions. 3 illustrations. 2,100 words.—*Schiffbau,* August 11.

Some Technical Aspects of Shipbuilding Contracts.—By H. Bocler. The object of this article is to briefly consider how the shipbuilder in actual practice deals with the preliminary considerations entailed by contract guarantees or requirements in regard to deadweight and draft, cubic capacity, trim, stability, flotability when damaged, strength, speed and power, and to explain the nature and form of calculations which the author has found convenient for this purpose. Strictly speaking, the various technical factors react upon one another and cannot be considered separately, their final relationship in a particular case being evolved by a process of trial and error. For descriptive purposes, however, each factor is treated independently. Guarantees in regard to deadweight at a given draft involve three main considerations—freeboard, fineness of ship and light weight of ship. Freeboard is settled by law and presents no further uncertainty than that involved by a possible wrong interpretation of the freeboard tables. The question of fineness is best considered in re-

lation to speed guarantee, and in so far as deadweight guarantees are concerned may be considered a known quantity. The chief element of uncertainty occurs in respect to the light weight and considerable experience is needed to form a reliable estimate of this. Builders' margins on deadweight should, therefore, be considered as a percentage of the light weight and not of the deadweight. In the case of passenger vessels a margin of at least 2½ percent should be allowed, while in cargo ships 1 to 1½ percent should be sufficient. The principal methods of estimating light weights are: (*a*) By coefficient, (*b*) by the use of curves, (*c*) by comparative estimating from a vessel already built, or (*d*) by calculation in detail. (*a*) is very approximate and should be used for first approximations only, (*b*) does not provide sufficient accuracy for a particular case, and should be used for only rough approximations, (*c*) is the most reliable method, while (*d*) is a long and tedious process and presents greater chances of error than the comparative method. It should only be employed when no suitable basis ship is available for a relative calculation. Guarantees in regard to cubic capacity can, as a rule, be agreed to without great risk. The unknown element lies mainly in the approximate nature of the method adopted for preliminary calculations made before the "lines" are designed. Without "lines" a margin of 2 to 3 percent should be allowed, but where "lines" are available for a detailed calculation of the capacity, 1 percent should be ample. The following methods are useful for estimating capacities: (*a*) By coefficient, (*b*) by geometrical variation of form. The latter method is very accurate and convenient when a suitable basis form is available. Guarantees as to trim involve two main considerations, the adjustment of weight and buoyancy to suit a basis condition (generally the load condition), and the relative trim under different conditions of service, a matter which is practically independent of the position assigned to the center of buoyancy to suit the basis condition. The question as to the amount of stability a vessel should possess is a difficult one and is not considered in this article. The usual contract requirement as regards stability is for a certain metacentric height under certain specified conditions. The determination of the metacentric height involves two factors—the form of the vessel and the vertical distribution of weight in the stipulated condition. The writer points out that in practice there is usually a tendency to underestimate the vertical height of the center of gravity, especially in the case of large passenger liners. A suitable margin for vessels of this class seems to be an allowance of at least 4 inches higher than the calculated figure. The remaining contract guarantees are to be taken up in a later issue of the magazine. 4 illustrations. 7,000 words.—*The Shipbuilder,* July.

The Exploration Ship Albatross, of the Zoological Station in Rovigno.—After giving a short historical account of the development of the zoological station in Rovigno, on the Adriatic Sea, in connection with the Berlin Aquarium, the author points out that the need of a special vessel led to a consideration of the most suitable type and size of craft for this special purpose. Two different sizes of vessels were considered—one about 37 feet long, the other about 53 feet long. The latter type was chosen, and its construction was ordered at the Havel shipyard in Potsdam. The characteristics specified for the vessel were as follows: Wood hull, seaworthiness, good speed, quarters for accommodating two or three scientists for several days at a time; a clear after deck for working the nets and sorting the catch, accommodations for a small crew, and low cost of operation, with a cruising radius of several days. The auxiliaries included a net winch, an auxiliary air compressor, a dynamo and searchlight, a windlass for anchoring in water up to 160 fathoms, a deep-sea sounding winch for working up to 2,200 fathoms. With skillful design, these characteristics were incorporated in the vessel, and the equipment was successfully located in the somewhat cramped quarters. The dimensions of the hull are: Length, 53 feet 4 inches; beam, 13 feet 6 inches; depth, 9 feet, and maximum draft, 6 feet 4 inches. The motor is an 80-horsepower, 2-cylinder, double-piston Junkers, 7 inches diameter by 10 inches stroke, crude-oil engine, arranged forward. The crew is berthed forward and the captain in the pilot house, while amidships is a living room with berths for four or five persons. Aft of the living room is a passage on the starboard side and a scientific laboratory for two or three scientists, with tables, lockers and two berths, as well as a toilet on the port side. In the stern is a fish bin with glass top and a lazarette for sails and nets. To get the necessary head room, a trunk about 20 inches high is provided over the living quarters. The pilot house has an adjustable searchlight, which can be housed in a box aft; also, the necessary steering and navigating appliances. The main engine shaft is fitted with a reverse coupling for a three-bladed feathering wheel. The oil tanks have a capacity of about 2 tons, which is sufficient for a five-days' run at full power. All of the auxiliaries are driven by belt or gearing from a 4-horsepower motor. The vessel has a ketch rig, and the composite hull is classed by German Lloyds. The trials proved satisfactory, and only the outbreak of war prevented the vessel from entering service at her station. 23 illustrations. 3,000 words.—*Zeitschrift des Vereines Deutscher Ingenieure,* June 26.

Recent Investigations and Measurements by Pitot Tubes in Propeller Stream Lines.—Experiments are described, made in the small tank of the German Polytechnicum, Charlottenburg, for finding the speed and pressure variations over the disk area of a ship's propeller. The apparatus is described as a Pitot tube with gage adjustable in three directions for covering the full disk at variable axial positions and mounted upon the carriage of the tank. The experiments were conducted so far only upon a propeller driven by an electric motor upon the stationary carriage in one position 3 inches aft of the propeller and in three positions directly in front of the propeller at progressively increasing number of revolutions. The conclusion the author comes to is that there is a forward movement of water aft of the disk of the boss, while aft the major part of the blades it shows the water passing aft except at the tip of the blades, where again a forward movement is recorded attributed to eddy influences. The movement of the stream lines forward of the propeller are all toward it and over a disk area of more than one and a half times the diameter of the propeller distinctly perceptible velocities are recorded. The author gives this series only as preliminary, the war interrupting the experiments by calling away the man in charge and turning the tank room into a hospital. 18 illustrations. 2,100 words.—*Schiffbau,* July 28.

Naval Scouts.—By Commander Ralph Earle, U. S. N. Taking the ground that battle-cruisers, the ideal scouts, are probably out of the question for the United States on account of their great cost and the folly of building less than a homogeneous division of five, the author makes a strong plea for the building of a sufficient number of light scout cruisers of about 5,200 tons displacement and 28 knots speed to round out a well-balanced navy. 13 illustrations. 10,000 words.—*United States Naval Institute Proceedings,* July-August.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

The demand for the construction of merchant vessels in American shipyards has increased to such an extent that most of the large shipyards on the Atlantic coast are refusing to accept orders calling for delivery before the end of 1917. During the last week in August one large shipbuilding company refused the opportunity to bid on six large vessels, as they were unable to guarantee deliveries inside of three years or more. The situation is well illustrated by the fact that the Ward Line placed an order for two freight steamships with a shipbuilding company in Seattle in order to secure fairly prompt delivery, and another steamship company placed an order in San Francisco, although the vessels are intended for Atlantic service.

The Delaware River district is at the present time the greatest shipbuilding center in the United States, and, counting warship construction, the volume of tonnage now under construction in that district is surpassed only by that at Glasgow. Excluding warship tonnage, the three great shipbuilding centers in Great Britain—Belfast, Glasgow and Newcastle-on-Tyne—are the only shipbuilding centers in the world that lead the Delaware River district.

Shipbuilding Orders

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has received a contract to build two more colliers for the Crowell & Thurlow Steamship Company, Boston, Mass. These ships will be about 9,000 tons deadweight.

The Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., has received a contract from the Trans-Atlantic Motor Ship Company, Ltd., Christiania, Norway, to build two oil tank vessels to be equipped with Bolinder oil engines. This order is in addition to that reported in our August issue.

Orders for six 12,000-ton steamers have been placed by the Osaka Shosen Kaisha Steamship Company, of Japan, with an iron works in Osaka, Japan. The vessels are to be 425 feet long.

The Merrill-Stevens Company, Jacksonville, Fla., was recently awarded the contract for the construction of the United States lighthouse tender *Palmetto* at a cost of $28,975 (£6,000).

The Commissioner of Purchases and Supplies, City Hall, Cleveland, Ohio, has recently opened bids for the construction of the steel hull of a fireboat.

Shipbuilding Contracts Pending

W. H. McWhinney, Aberdeen, Wash., is organizing a company to build a steam schooner to cost $100,000 (£20,500).

The Pacific-Alaska Navigation Company, H. F. Alexander, president, San Francisco, Cal., announces that his company expects to build or buy two steamers for Alaska service.

The Navy Department, Washington, D. C., will open bids on November 17 for the construction of two 32,000 ton battleships. These will be the largest and most powerful ships ever designed for the American navy. The cost of each, exclusive of armor and armament, is limited to $7,800,000 (£1,600,000).

The Ocean Steamship Company (Savannah Line), Pier 35, North River, New York, has had plans for months to build two ships, each 416 feet long. These vessels are meant primarily for coastwise service, but will be constructed to meet the needs of transatlantic voyages. Contracts will be placed as soon as some shipbuilder and the company can agree on prices and time of delivery.

New Steamship Lines

It has been announced in Madrid, Spain, that a new steamship line between Spain and the United States is to be established.

It is reported, apparently on good authority, that a $5,000,000 (£1,070,000) company has been financed for the organization of a Chinese-American Steamship Company to operate between China and the United States Pacific coast.

A barge line to operate between Lake Charles, La., and Port Arthur, Texas, has been organized by Frank Warren, of the Warren Dredging Company, and will, so it is reported, shortly be placed in operation. Twelve barges and a canal boat are said to have been already purchased.

It is reported that Wm. J. Conners, Buffalo, N. Y., is at the head of a corporation which has been organized to effect a merger of the railroad owned steamship lines operating on the Great Lakes, which must be separated from the railroads by December 1 under the decision of the Interstate Commerce Commission.

Shipyard Improvements

The Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., will, so it is reported, spend about $200,000 (£43,000) in the further enlargement of its present plant, in addition to the $200,000 (£43,000) which it is already spending for that purpose.

The Collingwood Shipbuilding Company, Collingwood, Ontario, is refitting part of its plant for the manufacture of shells and high explosives.

The Maryland Steel Company, Sparrows Point, Md., is receiving bids for the construction of a one-story machine shop, 180 feet by 425 feet, for the marine department.

Important extensions and improvements, it is said, will be undertaken in the near future by the Spedden Shipbuilding Company, Baltimore, Md.

The Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., has awarded the contract for the construction of a shop to cost $100,000 (£20,500) to the Chesapeake Iron Works.

The Gould Storage Battery Company, Depew, N. Y., which furnishes many of the electric storage batteries for United States submarines, has recently let a contract for the construction of a two-story addition, 75 feet by 200 feet, to its plant.

William Cramp & Sons Ship & Engine Building Company has placed an order with the Pawling & Harnischfeger Company, Milwaukee, Wis., for nineteen 5-ton wall cranes to be installed at its works.

It is reported that a new corporation will take over the shipbuilding plant of the Herreshoff Manufacturing Company, at Bristol, R. I., and that the capacity of the plant will be very much enlarged. Paul A. Rainey, New Haven, Conn., is mentioned in connection with the enterprise.

Marine Terminal Projects

The City of Augusta, Ga., is planning to spend $60,000 (£12,800) in building wharves.

Brown & Watson, Palm Beach, Fla., have received a contract to build a stone pier at Palm Beach.

The City Commission of Tuscaloosa, Ala., is preparing plans for the construction of a municipal wharf.

The Baldwin Locomotive Works, Philadelphia, Pa., has been granted permission to erect a pier on the Delaware River.

The Board of Port Commissioners, New Orleans, La., is preparing plans for the construction of a wharf to cost about $70,000 (£15,000).

J. A. McEachern, Seattle, Wash., has received a contract to build a pier at Flavel, Ore., for the Great Northern Steamship Company.

S. D. Shinholse, Jacksonville, Fla., has received a contract to construct a dock and warehouse for the Clyde Steamship Company at Sanford, Fla.

The Pennsylvania Railroad Company, Philadelphia, Pa., has let a contract to the Snare & Triest Company, New York, to build a pier at Greenville, N. J.

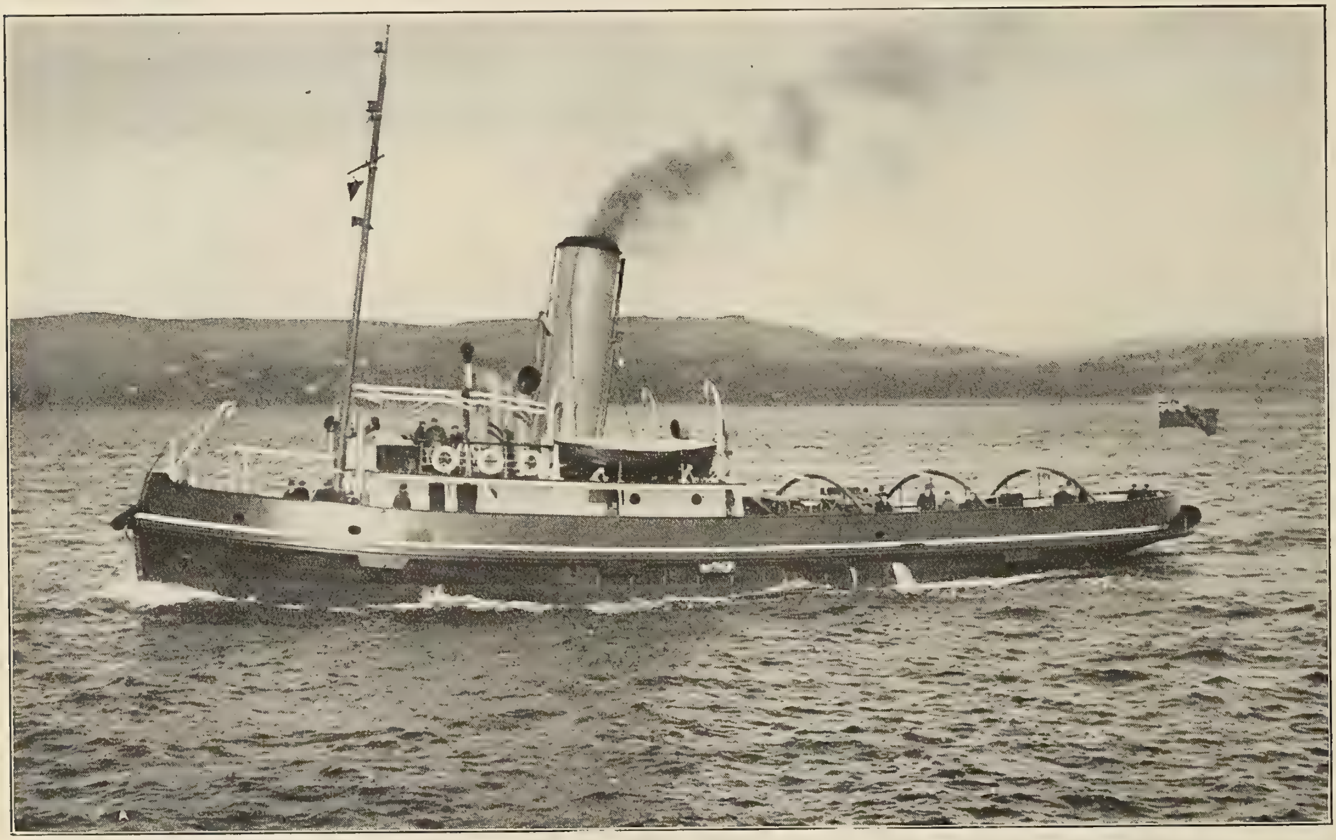
The State of Texas has approved the $325,000 (£69,600) bond issue recently voted by the City of Orange. About $150,000 (£32,000) of this money is to be spent on wharves and docks.

The Baltimore & Ohio Railroad Company, Baltimore, Md., Daniel Willard, president, is planning the construction of a $1,000,000 (£205,000) coal pier at Curtis Bay, Baltimore.

The city of Pascagoula, Miss., has purchased a site on the Pascagoula River to build wharves and docks. The mayor of the city has the matter in charge.

C. W. Hunt Company, West New Brighton, S. I., has received a contract from the Inter-Island Steam Navigation Company, Honolulu, T. H., for a $1,000,000 (£205,000) coaling plant at Honolulu Harbor.

The Rio Grande Railway Company, Brownsville, Texas, A. Albert Browne, president, has submitted a proposition to the city of Brownsville, to rebuild the wharf at Point Israel and further improve the town's terminal facilities.



Passenger Tender and Tug *J. W. Sauer*. Built by Messrs. Ferguson Brothers, Ltd., for South African Government

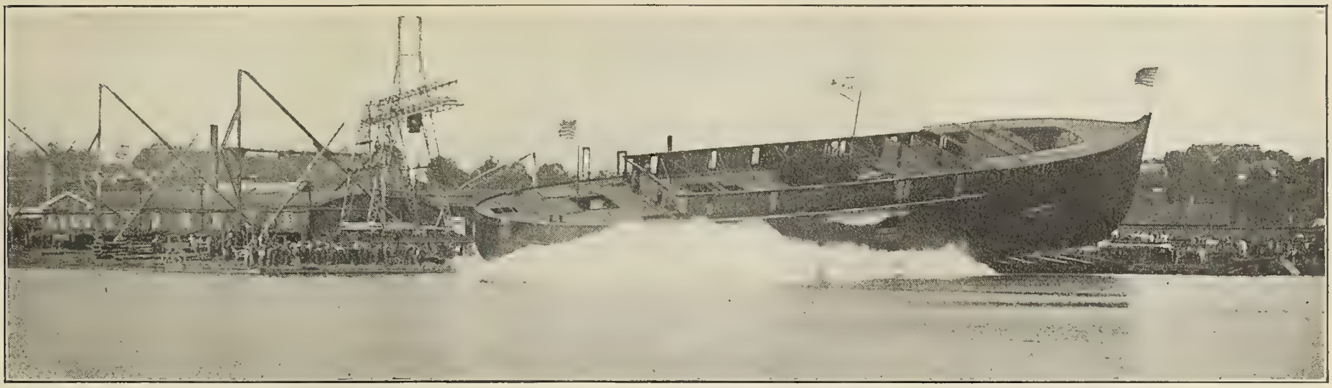
The Department of Public Utilities, city of St. Louis, Mo., S. W. Bowen, designing engineer, is contemplating the construction of a number of docks to be equipped with up-to-date freight-handling machinery.

Irwin & Leighton, 126 North Twelfth street, Philadelphia, have received a contract from the Ocean Steamship Company, New York, to construct pier sheds at Savannah, Ga. J. G. Basinger, 52 Broadway, New York, is the engineer.

The Engineer of Docks for the Panama Canal is preparing estimates of the cost of constructing an additional 1,000-foot pier at Cristobal, and is also preparing estimates on the cost of replacing timber pier No. 11 with reinforced concrete construction.

The Terminal Transfer & Storage Company, of Mobile, Ala., will shortly begin construction on thirty-two acres of water front land at Mobile of an extensive marine terminal development.

The Gulf, Florida & Alabama Railway Company is building an additional pier at Pensacola, Fla., for the handling of coal. The loading machinery is being constructed by the Link Belt Company, of Chicago and Philadelphia.



Launch of the *Nevada* at the Yards of the Manitowoc Shipbuilding & Dry Dock Company

Twin Screw Passenger Tender and Tug for South Africa

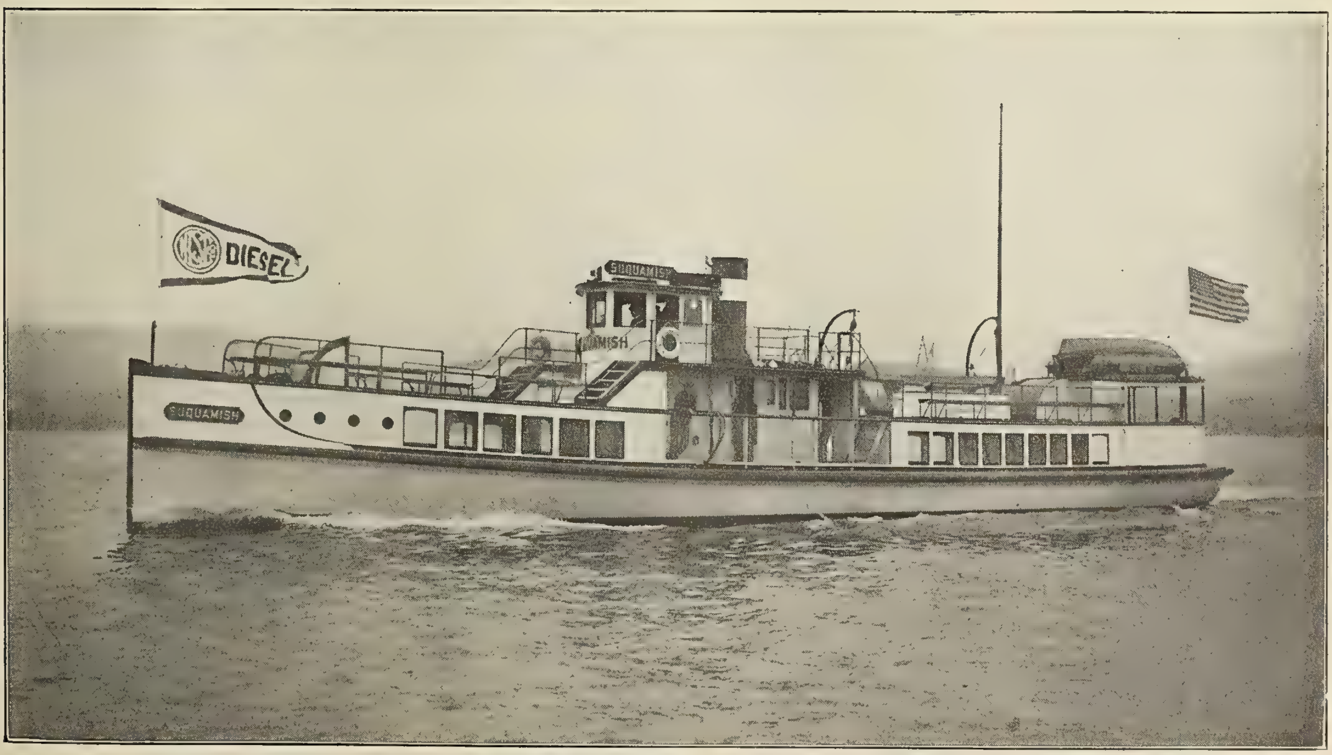
The twin screw passenger tender and tug *J. W. Sauer* illustrated on page 468 is the third vessel of this class which Messrs. Ferguson Brothers (Port Glasgow), Ltd., have built and engined for the Table Bay Harbor Department for the Union of South African Government. The propelling power consists of two sets of triple expansion surface condensing engines with bronze propellers for which steam is supplied by two large multitubular boilers. The vessel is capable of a speed of 12½ knots, which is in advance of the contract speed. In order to provide the vessel with a large radius of action, the coal bunkers have a capacity of 100 tons, and there are a double bottom and deep tanks for boiler feed water, culinary water and fresh water for supplying water to shipping. The machinery auxiliaries comprise a powerful steam winch aft for warping purposes, steam and hand steering gear on the bridge deck, target towing machine, electric engine and dynamo, two centrifugal circulating pumps, separate feed pumps, fire and salvage pumps, separate general service pumps, fan and engine with trunk to stokehold, ash ejector and pump.

Passenger Motor Ship Suquamish

The first Diesel-engined passenger boat in America is the *Suquamish,* owned by the Kitsap County Transportation Company, Seattle, Wash., and operated between Seattle, Wash., and Paulsbo, Wash. The vessel is 92 feet long, 16 feet beam and on a 5-foot draft carries 180 passengers.

Propulsion is by a 180-horsepower Nlseco four-cycle, six-cylinder, vertical single-acting Diesel engine, built by the New London Ship & Engine Building Company, Groton, Conn., which runs at 350 revolutions per minute, giving the vessel a speed of 14 miles per hour. The cost for fuel and lubricating oil averages only 24 cents (1/0) per hour. A supply of fuel oil for two weeks is carried, although there is space for a month's supply. Only one man is required for handling the engine, although on account of the fact that the vessel is in operation from 6 A. M. to 8 P. M., two engineers are required to stand alternate watches.

Owing to the fact that the three round trips which the vessel makes daily include 42 landings, there is a splendid opportunity to test the endurance of the boat, as the clutch and reverse gears are constantly in use at these



The First Diesel-Engined Passenger Boat Built in America. Propulsion is by a 180 Horsepower Nlseco Engine

landings and the vessel is worked many times under the strain of the "spring line" tied to the wharves. The owners of the *Suquamish* have a number of other vessels of similar size and power engaged in similar trade which, however, are driven by steam, and therefore an opportunity is given for a direct comparison of the two methods. Under these conditions, it is said that the *Suquamish* has given most economical and satisfactory service as compared with the steam-driven vessels.

September Launchings

The United States submarine boat M-1, 185 feet long and 740 tons underwater displacement, was launched by the Fore River Shipbuilding Corporation, Quincy, Mass., on September 14.

The cargo steamer *Annette Rolph,* 9,000 tons deadweight, was launched at the Union Iron Works, San Francisco, Cal., on September 4, seventy-three days after the keel was laid. Her sister ship, the *Eurana,* was launched September 11.

The new steel steamer *Nevada* (described in our August issue), which is being built by the Manitowoc Shipbuilding & Dry Dock Company, Manitowoc, Wis., for the Goodrich Transportation Company, was launched on September 15.

The oil tanker *Silver Shell,* the first of three sister ships building at the yards of the Harlan & Hollingsworth Corporation, Wilmington, Del., for a subsidiary of the Anglo-Petroleum Company, of London, was launched on September 4. The vessel is 435 feet long.

The collier *Plymouth,* 335 feet long, 55 feet beam, 34 feet 6 inches load draft, designed and built by the New York Shipbuilding Company, Camden, N. J., for the Coastwise Transportation Company, Boston, Mass., was launched September 10. The *Plymouth* is a duplicate of the steamer *Franklin,* recently completed. She is propelled by engines of 2,000 horsepower designed to give an average speed of 11 knots.

The steam yacht *Whileaway,* 177 feet long over all, 23 feet 6 inches beam and 7 feet 6 inches draft, designed by Messrs. Cox & Stevens, New York, for Mr. Harry Payne Whitney, was launched by the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., on September 9. The yacht will be propelled by two Parsons geared turbines supplied with steam from an oil-fired tubular boiler. The designed speed is 21 miles an hour.

Remarkable Savings Effected by Using the Oxweld Process in Repair and Reclamation Work of Varied Character on Ore Vessels

The Oxweld Acetylene Company of Chicago, Ill., and Newark, N. J., has recently completed contracts in connection with the winter repair work covering welding and cutting on thirteen ore vessels on the Great Lakes. The work executed was in many cases pioneer work in the particular field, and in all cases resulted in a considerable saving in actual cost, not to mention an enormous saving of time, compared with the usual methods of repair or replacement.

Perhaps the most successful application of Oxwelding on hull repairs was to cast iron mooring line chocks, windlass room chocks and towing chocks. Those so badly worn away by wire lines as to be scheduled for renewal were built up and filled in. In cases where the lip above the sheave was broken off entirely a new casting was made and welded on, giving the chock a new appearance and its original strength. Badly worn chocks were repaired by the Oxweld process at a cost ranging from \$8 (1/13/4) to \$30 (6/5/0), where renewals would have meant a cost of \$100 (20/16/8) to \$150 (31/5/0). Chocks were welded in place in from two to seven hours.

Scuppers, which require such precise pattern making in renewing as to make the cost of material a comparatively small item, were welded with absolute success, eliminating the time and expense of making and fitting new patterns. Cracks varying in length from one to four feet were welded at a total cost varying from \$10 (2/1/8) to \$20 (4/3/4). The time required to remove, weld and reset the scupper was about two days.

As a time saver in cutting steel plates, structural steel, brass, etc., remarkable claims are made for the Oxweld process. Old bulkheads battered and torn were trimmed or cut away with great speed. Steel plates a half-inch thick were cut at the rate of one foot per minute. There was literally miles of cutting done on these vessels. Walestrakes were cut off, bulkheads trimmed, dead lights cut, brackets, channel flanges, stringers, web frames and bilge plates were all cut out or trimmed.

On one vessel Oxweld apparatus was used to cut off some ten feet of spar. While the cost of cutting per lineal foot is only about one-half the cost involved in drilling and chipping, the enormous amount of time saved with the Oxweld process proves its superiority. With the cutting blowpipe beams and plates were cut down in minutes where the old method would have taken hours.

Cracks in some ⅝-inch steel plate tank tops were Oxwelded at an average cost of from 40 to 50 cents (1/8-2/1) per inch. A riveted patch for a crack 5 inches long would have cost \$30 (6/5/0) at least, while it is claimed the same crack could be Oxwelded for \$2.50 (10/5).

The intermediate stringer channel flanges, which become so battered and bent by the unloading machines, were heated by the Oxwelding blowpipe in an incredibly short time and straightened by means of alligator jaws operated by two men. When completed the channel has a new appearance and is protected from further wear of this kind by the insertion of a 3-inch oak filler in the wake of the hatches. These fillers are held in place by bolts through the web of the channel. The bolt holes, ¾ inch in diameter, are cut by the Oxweld cutting flame at the rate of one a minute, costing about 6 cents (0/3) each. In many cases the entire flange and part of the web of the channel had been broken out for a distance of from one to four feet, greatly weakening the stringer. Such places were trimmed up square and a section cut from new material to fit, and welded in the gap. No other tools than the Oxweld torches were used in this operation—not a rivet was driven—and when completed the fractured flange was restored to its original strength.

Welding propeller blades, propeller shafts, rudders and shoes, not to mention welding repairs of all varieties in and around boilers, are applications of the Oxweld process of daily occurrence in shipyards. Oxwelding applied to hull repairs, however, is a new departure, which promises to open up a very large field and effect immense savings in time and money to vessel owners.

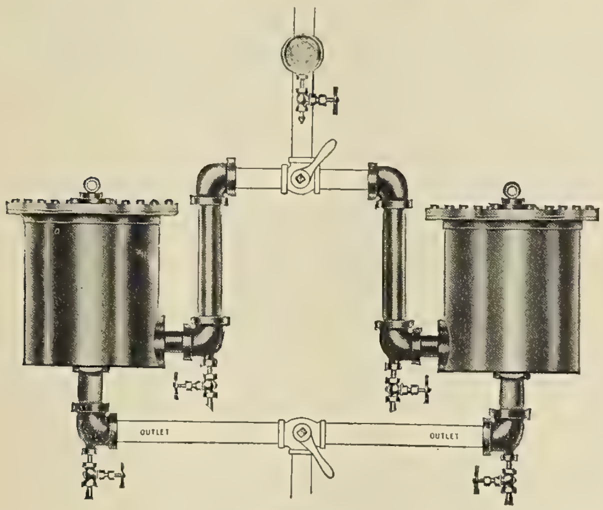
Greek Merchant Marine Expanding.—Statistics recently published in Greece show that in the eighteen months ending December 31, 1914, there were 85 steamers of 219,450 gross tons added to the list of ships sailing under the Greek flag. According to Lloyd's Register, the number of vessels in the merchant fleet of Greece at the end of 1914 was 440, with a gross tonnage of approximately 900,000.

ENGINEERING SPECIALTIES

What Oleite Does

"Deolizer" is the trade name of an instrument for the complete removal of oil from emulsion. It is manufactured and sold by William Andrews, Inc., 120 Liberty street, New York. To de-ole-ize means to de-oil-ize, or take out oil. The material which does this is sold under the trade mark of "Oleite."

Oleite is a discovery, not an invention. The original investigators were endeavoring to perfect a roofing material having certain desirable qualities. In running down the line of experiment they accidentally discovered that at a certain stage of the manufacture the material developed a singular natural affinity for oil, an affinity analogous to that of cement for water. Following up this discovery it was found that Oleite would remove 99.99994 percent of all the oil from an emulsion. So complete was this purification, it is claimed, that it required the delicate ether test to detect the residue, which is equal to about one drop in one and a half barrels of water. The application of Oleite, therefore, in the treatment of condensed returns, whether from heating systems or surface condensers, was at once undertaken and has been followed up with remarkable results.



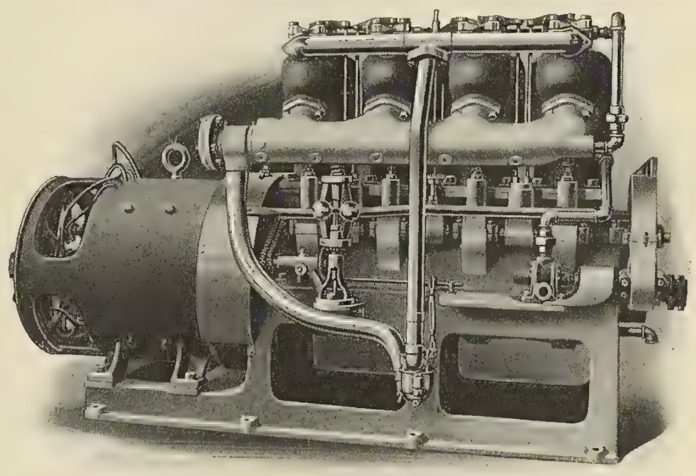
"Deolizer"

Although the apparent action of Oleite is that of a filter, its real action in no way resembles the ordinary mechanical straining implied in the term filter. Oleite is a calcined mineral substance granulated to a uniform grade, and in appearance much resembles old-fashioned black gunpowder. The voids are large and if sand or charcoal were used there would be no perceptible effect on the emulsion. Oleite, on the contrary, acts by a remarkable and thus far unexplainable attraction for, and entanglement of, the emulsified particles of oil. It is claimed that it seizes upon every minute atom within reach and, once seized, it never lets go. In time the Oleite is found to coagulate the oil in its voids until the whole mass becomes a sort of jelly. It can be forced to part with the oil only by burning it off. The Oleite itself does not materially suffer by the operation and can therefore be recovered and used a number of times before losing its efficiency.

The action of the Deoleizer is supplementary to the action of the ordinary oil extractor. The latter is set in the flow of the exhaust steam. The former takes the oily returns after condensation and reduces them to a distilled water of limpid clearness and perfect purity in which there is not a measurable trace of oil. This last fractional percent of oil is the elusive one, hard to catch but cumulative in its damage if it gets into the boiler.

Speedway Auxiliary and Emergency Electric Lighting Set

The Gas Engine & Power Company and Chas. L. Seabury & Co., Cons., Morris Heights, New York, has placed on the market a combination auxiliary and generating set such as is now required by law for steam passenger vessels. These generating sets are built in stock sizes of 3, 4, 7, 12 and 25 kilowatts. The larger sets are arranged solely for electric lighting, but the 3 and 4 kilowatt sizes include in addition to the generator a bilge and fire pump and an air compressor. These sets are especially suited to yacht work where the main gasoline (petrol) engines require air for starting purposes. In the smaller sets the engine consists of three vertical cylinders, 4½-inch bore by 5-inch stroke mounted on a cast iron closed frame which in turn is bolted to a body with extension for the generator. The power cylinders are on the ends, while the center cylinder is an air compressor with mechanically operated intake valve. On the end opposite the generator, attached to base plate, is a double-acting bilge pump, 3½-inch bore by 4-inch stroke.



12 K. W. Speedway Lighting Set

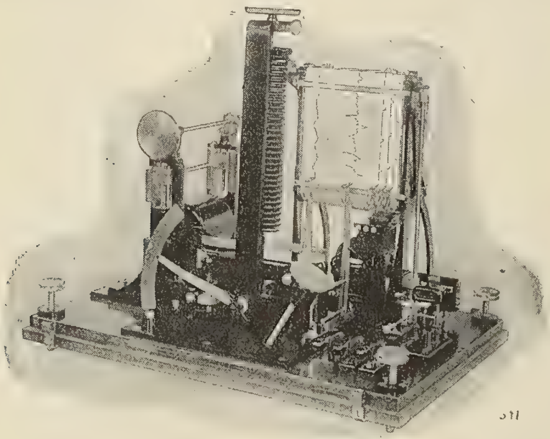
The Pallograph

The only pallograph in America, and, in fact, one of but two or three in existence, has just been completed by the Sperry Gyroscope Company, Brooklyn, N. Y., for use at the Government model basin, Washington, D. C., in connectiton with investigations of the vibration of ships.

Briefly, the pallograph is an instrument which simultaneously records vertical and horizontal transverse vibrations, and while the instrument is primarily intended for use aboard ships, it may be used to trace vibrations or oscillations of any character to their primal source. Its usefulness was strikingly demonstrated several years ago by Dr. Schlick, of Hamburg, Germany, in connection with the trial trip of the Cunard liner *Lusitania,* where excessive vibrations developed at high speeds. Sir William White had been much interested in Dr. Schlick's experiments and it occurred to him that if Dr. Schlick could be persuaded to bring his pallograph to England the trouble might be located.

Accordingly a telegram was dispatched and Dr. Schlick

was soon at his task. Working for nearly forty-eight hours, without rest, he finally traced the trouble down to one of the tail shafts; moreover, he reported he was convinced that a blade of the propeller on that particular shaft had not been properly set, and, furthermore, that it was some 2 degrees out of alinement! Such confidence was placed in Dr. Schlick's deductions that the ship was immediately docked, the propeller blades examined and one actually found to be 1.8 degrees offset. Little time was lost in adjustment and the *Lusitania* resumed her interrupted trip—but vibration had been eliminated. Dr. Schlick afterward said that the stern appeared to "jump up and down about a foot," the vibration at other points being not so violent; yet here and there were nodes where



Sperry Pallograph

no tremor was felt—in fact, the great ship behaved as a gigantic violin string.

The Sperry pallograph embodies a number of substantial improvements over the Schlick device, possibly the most important being mechanism which so regulates its period that it will not come into synchronism with any harmonic of the ship's motion. Of equal importance is the introduction of pencils for (1) indicating revolutions of the ship's shafts and (2) a time marker indicating seconds. Records are made on a 5-inch paper strip, moved upwardly at constant speed by a small motor; the speed of travel may be regulated from 1½ inches down to ⅝ inch per second, as required. It will be readily understood that vibrations of high frequency or of considerable amplitude should be recorded on a rapidly moving strip so that the wavy lines of the diagram will be widely separated for thorough analysis—indeed, it is even frequently necessary to enlarge certain sections so that conclusions as to the causes of the vibrations may be determined with absolute certainty.

When the pallograph is in operation the "pendulum" appears to oscillate and vibrate rapidly, whereas in reality it is standing absolutely still and the pallograph structure is moving in unison with the body on which it rests.

The general dimensions of the apparatus are 24 inches long, 14 inches wide and 20 inches high; the weight is approximately 90 pounds.

American Citizens Command the Majority of Foreign Built Ships Admitted to American Registry.—Two-thirds of the officers of the foreign built ships admitted to American Registry under the act of August 18, 1914, are American citizens or are men who have taken out their first naturalization papers in the past and will become citizens of the United States after a lapse of varying periods.

PERSONAL MENTION

Operating Engineers

Leo Tillman has been appointed chief engineer of the steamship *California.*

W. G. Oyler is chief engineer of the Border Line steamship *Fulton,* now on the Pacific coast.

George H. Parry has been appointed chief engineer of the tug *E. H. Willard,* of New Orleans, La.

Albert Clark, of New Orleans, La., has been appointed second assistant engineer of the Texas Company's steamer *Louisiana.*

E. H. Milde has been appointed second assistant engineer of the Southern Pacific steamer *Chalmette* at New Orleans, La.

Peter Dietz has been appointed chief engineer of the tug *Robert N. Day,* which is employed on construction work at Albany, N. Y.

A. Boyd, R. Powers and J. Hillary are assistant engineers on the steamship *William O'Brien,* of the Carpenter-O'Brien Company, New York.

Joseph Blunk has been appointed chief engineer of the tug *A. H. Whiteman,* of New Orleans, La., with Raymond Saunders as assistant engineer.

Charles Delacroix, of New Orleans, La., has been appointed chief engineer of the steamer *Natchez.* Hubert Fielder is first assistant engineer.

J. H. Howe, of Cincinnati, Ohio, formerly chief engineer of the *Island Queen,* has been appointed chief engineer of the towboat *Barrett* at Cairo, Ill.

R. J. Welch is chief engineer of the Cuba Distilling Company's steamship *Currier,* which is undergoing repairs at Shewan's yard in Brooklyn, N. Y.

S. F. Alexander is acting chief engineer of the Southern Pacific steamship *El Occidente* during the absence of S. T. Alexander, who is chief engineer of this vessel.

T. E. Dickow has been appointed chief engineer of the large excursion steamer *Island Queen,* of Cincinnati, Ohio, with Clarence J. Scales as first assistant engineer.

C. A. Anderson is acting chief engineer of the Southern Pacific steamship *Antilles* during the absence on account of illness of Gus Atkins, chief engineer of the vessel.

A Berg, formerly chief engineer of the Pacific Coast steamship *Tampico,* has been appointed chief engineer of the *Montara* of the same company, vice George C. Brodersen, resigned.

Melvin Leap has been appointed chief engineer of the *Val T. Collins,* of the Island Creek Coal Supply Company, Huntington, W. Va. Phil Klipp is first assistant engineer of this vessel.

Joseph Stanton, of Athens, N. Y., has been appointed first assistant engineer of the tug *George E. Lattimer,* which is stationed on the New York State Barge Canal at Rexford Flats.

Charles Bortle, formerly chief engineer of the steamer *Julia Safford,* of the Albany & Troy Line, Albany, N. Y., has accepted a position with the Great Lakes Dredge & Dock Company.

Earl Bryan has been appointed chief engineer of the passenger and freight steamer *Ohio,* running between Cincinnati, Ohio, and Memphis, Tenn., with William H. Weber as first assistant engineer.

Frank B. Davis, for many years first assistant engineer of the steamer *Olivette,* of the Peninsula & Occidental Steamship Company, has been appointed an assistant boiler inspector in the United States Steamboat Inspection Service at New Orleans, La.

James Andus, formerly chief engineer of the steamer *St. Johns,* of the Colonial Beach Company, Washington, D. C., has been transferred to the steamer *Gratitude,* recently purchased to take the place of the steamer *Wakefield* on the Potomac River route.

Joseph Nash has been appointed chief engineer of the steamer *Volunteer,* of the Potomac & Chesapeake Steamboat Company, Washington, D. C. The *Volunteer* was partially destroyed by fire a few weeks ago, and as soon as repairs are completed she will be sent to the James River to run between the Dupont Powder Works plant and Petersburg.

Changes in Steamboat Inspection Service

W. K. Martin has been appointed assistant inspector of the United States Steamboat Service, New York.

Robert Clark has been appointed assistant inspector of the United States Steamboat Inspection Service, Boston, Mass.

Harry Lord has been appoined inspector of boilers of the United States Steamboat Inspection Service at Seattle, Wash.

Whitmore Hill has been appointed local inspector of boilers of the United States Steamboat Inspection Service at Galveston, Texas.

W. I. Gilman has been appointed local inspector of the United States Steamboat Service at Boston, Mass., succeeding Andrew J. Savage, resigned.

Silas H. Hunter has been appointed local inspector of boilers in the United States Steamboat Inspection Service at Cleveland, Ohio., vice James McGrath, resigned.

Philip J. Shaw has been appointed local inspector of boilers of the United States Steamboat Inspection Service at Providence, R. I., succeeding Charles A. Potter, deceased.

Harvey S. Haynes, local inspector of boilers at Evansville, Ind., and formerly chief engineer of the Corrigan fleet, has been appointed assistant local inspector of boilers in the United States Steamboat Inspection Service, at Cleveland, Ohio.

Naval Architects, Consulting Engineers, Draftsmen and Shipyard and Steamship Officials

F. K. Ruprecht, formerly a draftsman in the hull division of the New York Navy Yard, is with John A. MacAdam & Company, New York City.

William Binley, Jr., formerly chief draftsman at the New York Navy Yard, is now chief draftsman and assistant to the general manager at the Fore River Shipbuilding Corporation, Quincy, Mass.

Walter A. Read, formerly assistant chief draftsman at the New York Navy Yard, is president of the Read Collecting Agency, Boston, Mass., taking the place left vacant by the sudden death of his father.

R. Earle Anderson, formerly general manager of the Augusta-Savannah Navigation Company, Augusta, Ga., has been appointed assistant general superintendent of the Winchester Repeating Arms Company, New Haven, Conn.

Arthur Fuller, formerly Pacific coast sales agent of the New London Ship & Engine Company, Groton, Conn., has been appointed general sales agent of that concern, with headquarters at Groton, Conn.

Naval Advisory Board

The Secretary of the United States Navy announced on September 12 the names of the twenty-three engineers and scientists who will constitute the Advisory Board to assist the navy in its technical problems of development. Eleven of the leading scientific societies in the country were requested to nominate two members each to serve on the Board, and these nominations were approved by the Secretary of the Navy. The first meeting of the Board will be held in Washington on October 6. The following is the *personnel* of the Board:

Thomas A. Edison, Chairman.

American Society of Mechanical Engineers—Robert Le Roy Emmet, consulting engineer, General Electric Company, Schenectady, N. Y.; Spencer Miller, chief engineer, Lidgerwood Manufacturing Company, New York.

American Institute of Electrical Engineers—Frank A. Sprague, consulting engineer, New York; B. G. Lamme, chief engineer, Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa.

American Society of Civil Engineers—Andrew Murray Hunt, consulting engineer, San Francisco and New York; Alfred Craven, chief engineer, Public Service Commission, first district, New York.

American Electrochemical Society—Joseph W. Richards, Professor of Electro Chemistry, Lehigh University, South Bethlehem, Pa.; Lawrence Addicks, consulting engineer, Douglas, Ariz.

American Chemical Society—W. R. Whitney, Director of Research Laboratory, General Electric Company, Schenectady, N. Y.; L. H. Baekeland, Yonkers, N. Y.

American Institute of Mining Engineers—William Lawrence Saunders, Chairman, Board of Directors, Ingersoll-Rand Company, New York; Benjamin Bowditch Thayer, president, Anaconda Copper Mining Company, New York.

The Inventors' Guild—Peter Cooper Hewitt, consulting engineer, New York; Thomas Robbins, president, Robbins Conveying Belt Company, Stamford, Conn.

American Mathematical Society—Robert Simpson Woodward, president, Carnegie Institute, Washington, D. C.; Arthur Gorden Webster, Professor of Physics, Clark University, Worcester, Mass.

American Society of Automobile Engineers—Andrew L. Riker, vice-president, Locomobile Company, Detroit, Mich.; Howard E. Coffin, vice-president, Hudson Motor Car Company, Detroit, Mich.

American Society of Aeronautic Engineers—Henry Alexander Wise Wood, engineer and manufacturer of printing machinery, New York; Elmer Ambrose Sperry, president, Sperry Gyroscope Company, Brooklyn, N. Y.

American Aeronautical Society—Matthew Bacon Sellers, Director of Technical Board of the Aeronautical Society of America, Baltimore, Md.; Hudson Maxim, ordnance and explosive expert, Brooklyn, N. Y.

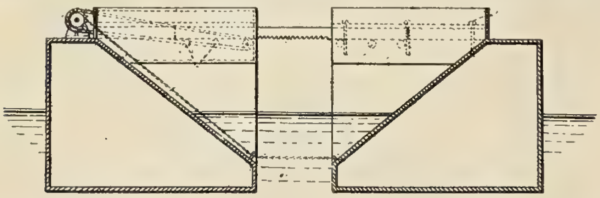
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Derbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,138,463. SELF-DUMPING SCOW. FRANKLIN PIERCE EASTMAN, OF NEW YORK, N. Y.

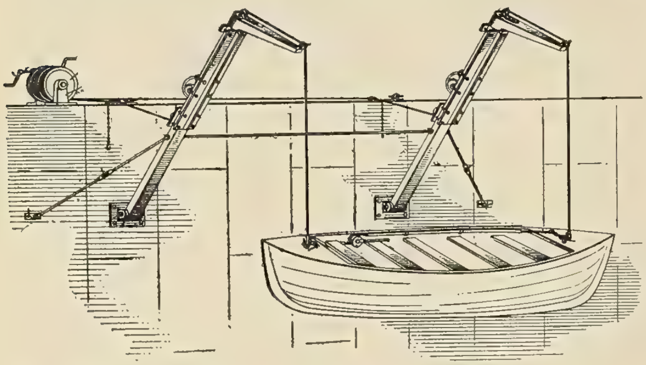
Claim 1.—A self-dumping scow, comprising two hulls affording between them a hopper for holding the load at the time the hulls are abutting sidewise and for allowing the load to dump automatically on



the hulls moving apart, and connecting means at a right angle to the length of the scow and slidably connecting the hulls with each other to maintain the hulls in the same plane when closed or open. Ten claims.

1,140,046. DEVICE FOR LAUNCHING LIFEBOATS. ROBERT WILLIAM LEEMING, OF BRANTFORD, CANADA.

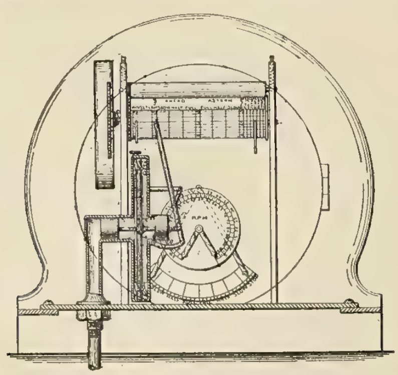
Claim 1.—A pair of davits, each of the said davits comprising a column or upright of channel shape, an arm rotatably connected with the upper end of the column or upright to revolve around the upright, a bracket adapted to be secured to a fixed support at each davit, a hinge connection between each column and the adjacent bracket for permitting the upper end of the column to swing outwardly and downwardly, said column



being adapted to extend above the boat deck of a vessel, a pulley journaled at the outer end of each arm, a pulley journaled on the arm near the top of each column, a pulley journaled on each column intermediate the ends thereof, a flexible member passing over the pulleys and having a davit hook at its outer end for engaging a boat to support the same, and brake mechanism in connection with each column for preventing movement of the flexible member, said mechanism being arranged on the column between the last-named pulleys and comprising a pair of blocks having registering grooves for receiving the flexible member, the blocks being connected with respect to each other, and means for clamping the outer block on the inner block. Twelve claims.

1,145,884. SHIP'S INDICATOR. EDWIN A. FISH, OF NEW LONDON, CONN., ASSIGNOR BY MESNE ASSIGNMENTS, TO FISH AUTOMATIC SHIP'S LOG COMPANY, A CORPORATION OF NEW YORK.

Claim 1.—A ship's log and recorder including a platen roll, means for feeding paper over said roll with a predetermined movement, a

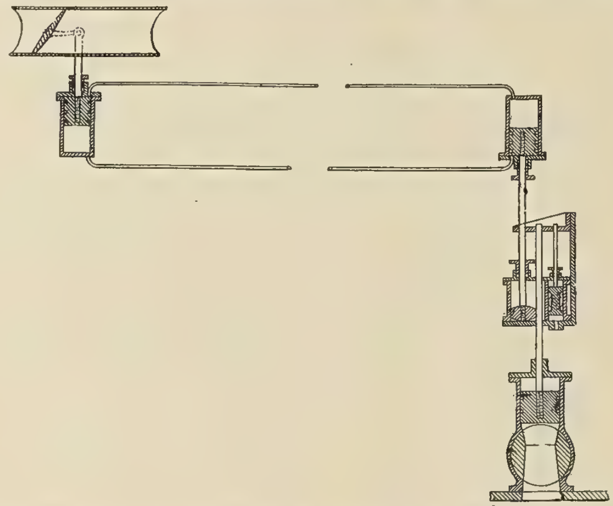


stylus, a flexible member, a cylinder, and a steam actuated piston therein connected with said flexible member for flexing the same, and connections between said flexible member and stylus embodying an arm and connections whereby said stylus is caused to traverse the paper with a movement parallel with the axial center of the platen roll. Six claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

12,736/1914. APPARATUS FOR PREVENTING RACING OF MARINE PROPELLERS. G. SHOTTON, 44 WESTBOURNE ROAD, PENARTH, GLAMORGAN.

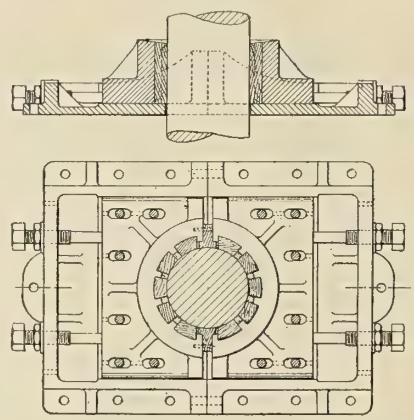
Claim.—An apparatus for preventing racing of marine propellers, consisting of a piston in a vertical cylinder open at its lower end to the water, the movements of which control the throttle valve of the propelling engine, and the displacements of which piston displace a lever



connected to a valve controlling the admission of fluid pressure to a motor cylinder having a piston connected to the throttle valve, the consequent displacements of the fluid-pressure-actuated piston returning the valve, by means of a lever of fixed fulcrum connected to the fluid-pressure-actuated piston rod and to the valve lever, in which the valve lever is pivoted on the lever of fixed fulcrum at an intermediate portion of its length.

13,053/14. STUFFING BOXES FOR RUDDER POSTS. W. C. J. COPEMAN, FURNESS HOUSE, BILLITER STREET, LONDON, E. C.

This invention has for its object to provide a stuffing box which shall be simple in construction, shall be easily adjusted to take up wear in the bearings of the stuffing box and shall, if desired, be self-lubricating. It comprises two adjustable cheeks, each of which is provided with a



semi-circular opening or recess to receive the rudder post, the said openings being provided with blocks of wood, say lignum vitæ, between which graphite or other lubricating material is placed, a base-plate is provided having a suitable opening therein to receive the rudder post. The two cheeks, each having the semi-circular opening, are arranged on the base-plate so as to be capable of adjustment and the cheeks may be firmly secured to the base-plate by means of bolts.

27,571/1913. IMPROVEMENTS IN OR RELATING TO FIRE EXTINGUISHING AND ALARM APPARATUS FOR USE ON BOARD SHIPS. F. W. SMITH, 5 THORNBURN AVENUE, AND H. S. WARREN, 79 MILLBROOK ROAD, SOUTHAMPTON.

In a fire extinguishing and alarm apparatus of the type in which one or more water pipes extend to compartments in a ship in which fusible plugs are employed to close water apertures either directly or through the agency of valves and in which means are provided in the branch pipes leading to each compartment, said means being operable by the flow of water in the branch pipes to give an indication at a suitable station of the particular apartment affected, the provision in connection with each compartment of a rotary water motor placed in each branch between the compartment and the main pipe, so that if a plug melts, the flow in the corresponding branch pipe operates the water motor which closes an electric circuit intermittently, and so causes to be given at a suitable station an alarm which appertains to the particular apartment affected.

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Western River Steamers

Western river boats of the extreme shallow-draft type, many of which are described in this issue, occupy a unique place in the art of shipbuilding. They are designed to meet the exceptional conditions of navigation on the Western rivers of the United States, where the stages of water vary from 12 inches to 70 feet, and where low-water periods prevail from three to five months of the year. Their design is based upon the practical knowledge of experienced river navigators and practical mechanics of a generation ago, rather than upon modern theories of naval architecture and marine engineering. In their general characteristics the modern sternwheel packet and tow boats differ little from the vessels that were built in the pioneer days of the development of the West, although in details of construction of both hull and machinery improvements and refinements have been widely adopted. Notwithstanding their apparently antiquated appearance, however, these vessels are likely to retain their position of superiority for the special services for which they are built until the continued improvement of the Western rivers has established new conditions of navigation.

Sternwheel Versus Tunnel Stern Boats

Although the sternwheel towboat is peculiarly adapted for the difficult operations of flanking, backing, drifting and quick handling in handling large tows downstream in the natural currents of the large Western rivers, such as the Mississippi and Ohio, the conditions of navigation on these rivers is gradually changing, especially on the upper Ohio and its main tributaries, where the completion of locks and dams will in a few years divide the river into a system of pools providing slack water or "pool" navigation during the late spring, summer and fall months. Under these conditions the peculiar advantages of the sternwheel towboat in flanking and backing, in handling large tows in "running" water, will not be so essential, and as the tows will be smaller, being limited by the capacity of the locks, it is probable that a different type of towboat will be developed to meet these new conditions. These facts are fully recognized by river navigators, as is acknowledged in the article on Western river steamers, published elsewhere in this issue. Under these circumstances it is not unlikely that the twin-screw tunnel stern type of towboat will be looked upon by river boat owners with more favor than has been the case hitherto, as considerable progress has already been made in the development of this type of towboat, with satisfactory results. For a shallow-draft propeller towboat the diameter of the propeller is, of course, an important consideration, and apparently the best possible solution of this problem so far advanced is the tunnel stern type of boat, in which the propeller, while not wholly immersed while the boat is at rest, may be provided with a solid stream of water to work in when the boat is in motion. In addition to this, by placing rudders aft of the propellers the steering qualities of the towboat when going ahead are exceptionally good. If the screw-propelled towboat proves successful in meeting the new conditions of navigation on improved inland waterways, it has the further advantage that there will be greater latitude for the adoption of improved and more efficient propelling machinery, a direction in which substantial economies should confidently be looked for.

Regulation of Steamship Lines

The recent investigation of shipping combinations by the Congressional committee on merchant marine and fisheries has directed public attention to the almost universal practice of steamship lines engaging in the American foreign trade to operate, both on the in-bound and out-bound voyages, under the terms of written agreements, conference arrangements or gentlemen's understandings, which have for their principal purpose the regulation of competition through either the fixing or regulation of rates, the apportionment of traffic, the pooling of earnings or meeting the competition of non-conference lines. Eighty such agreements or understandings involve practically all the regular steamship lines operating on nearly every American foreign-trade route. In the domestic trade similar agreements between steamship lines are few. Competition in rates between domestic lines, however, has been quite as effectively eliminated as in the foreign trade, either through the acquisition of steamship lines or the ownership of accessories to the lines, through agreements or understandings, or through special practices. The generally recognized advantages resulting from the agreements and conferences maintained in the foreign trade, if honestly and fairly conducted, it is believed by the investigating

committee, can be secured only by permitting the several lines in any given trade to co-operate through some form of rate and pooling arrangement under government supervision and control. Effective government control is also believed to be the only way in which the disadvantages and abuses inherent with steamship agreements and conferences as now conducted can be eliminated. A bill was, therefore, introduced at the last session of Congress providing that steamship lines engaged in the foreign trade of the United States be brought under the supervision of the Interstate Commerce Commission as regards the regulation of rates, approval of contracts and other conditions affecting the interests of the shippers. If this bill should become a law, rebating of freight rates would be made illegal, the use of "fighting ships" and deferred rebates would be prohibited and the Interstate Commerce Commission would be empowered to investigate fully complaints of unfairness as to rates and other discriminating acts on the part of the steamship lines. Suitable provisions are also incorporated in the bill for regulating the domestic lines; and as its enactment into law would undoubtedly tend to simplify the question of government aid to private lines, it should receive the support of shipping interests.

River, Lake, Bay and Sound Steamers

Shipbuilders in the United States have produced a special class of steam vessels for river, lake, bay and sound service of which they may be justly proud. These vessels range all the way from swift triple-screw, turbine-driven vessels to shallow-draft paddle-wheel steamers propelled by simple beam engines or compound inclined engines, some of them having a capacity of from 5,000 to 6,000 passengers. The main particulars of most of these vessels are well known and many of them have been described at length in previous issues of this journal. A review of the general characteristics of the hulls and machinery of these vessels which is of special interest, however, is given in a paper by Mr. Andrew Fletcher, presented at the International Engineering Congress in San Francisco.

Comparatively few of the river, lake, bay and sound steamers are built under classification rules, as the owners adhere largely to the constructional details of their previous steamers, in most cases adopting the suggestions of their naval architects and builders to suit the special demands of service. Except in cases of the large passenger boats of the Sound, Great Lakes and outside service types, single bottoms are generally used. Joggle shell plating has been extensively used rather than joggle framing, but in the opinion of the author of the paper the latter probably will be more generally adopted. Bulb angles, when readily obtainable from the rolling mills, have been largely used for frames, intercostals and deck beams. In recent years a greater amount of flanging in lieu of angle bars has been used for reverse frames, floors, intercostals, gussets and bulkheads. A system of longitudinal trussing from floors to main deck is very often used in the larger type of river steamers and the comparatively shallow-draft steamers on the inland lakes. A deck beam on every frame is the usual practice. The guard beams of the paddle steamers are generally bracketed to the gunwale strake and secured to the lodger plate rather than extending the main deck beams from outside to outside. Guard braces are usually of the truss frame type instead of the pipe or solid round bar construction. Sponsons, as a rule, are used only on the larger type of paddle Sound steamers. In screw steamers the shell plating is formed to act as sponsons where the guards overhang. In recent practice a greater number of watertight bulkheads unpierced by doors are used. There are two exits from each watertight compartment above floors and a more extensive and reliable pumping system for watertight compartments is provided, with duplication of pumps on the main deck on the large steamers.

As has been stated, the machinery of the paddle steamers varies from the old but very reliable simple beam engine to the more modern and efficient compound and three-cylinder compound inclined and four-cylinder compound, double inclined engines. The simple beam engine has great durability, low initial cost and low maintenance cost. The paddle wheels are of the feathering type with steel floats, and the engines work in some cases at a piston speed of 650 feet per minute. The boilers employed are of the old type of flue and return tubular boilers of 55 pounds per square inch working pressure, with long grates, high fireboxes and simple forced draft, both under and over the grates. These features make a satisfactory equipment for short or special routes for lake, river and harbor excursion boats.

Double poppet valves are used on simple beam engines, generally with fixed Stevens cut-off and, in some cases, with adjustable Sickle's dash-pot cut-off. Double trip shafts for raising the main steam and exhaust valves are used on the larger engines, one trip shaft being for use by hand and the other for operation by steam, as may be desired, when the boat is maneuvering or approaching or leaving a pier when the main valve eccentric gear is disconnected. The main valves of the inclined engines of the paddle steamers are unusually of the double-beat poppet type, although, in some cases, the box balanced slide valve is used on the high-pressure and double-ported side valves on the low-pressure cylinders. Stephenson link gear is generally used, although the Walschaert gear has given excellent results. Piston valves have also been extensively used.

The main air pumps are generally worked by the main engines. The condensers, main auxiliaries, feed-water heaters, filters, etc., are of customary types. While jet condensers have in the past been mostly used on the Great Lakes in combination with water purifiers, in recent years surface condensers have been largely adopted.

With inclined engines, boilers of the Scotch type with working pressures of from 130 to 180 pounds per square

inch are generally used, usually with Howden's system of forced draft. While Scotch boilers are generally used for the screw steamers, watertube boilers have been fitted to a number of vessels with excellent results. Superheated steam has not as yet been extensively used by vessels of this type.

Vessels of the types referred to in this paper are unsurpassed in any other part of the world in point of size, appointments, safety and efficiency. They represent a distinct achievement for American shipbuilders, and will long serve an an example for the kind of service for which they were designed.

Decline in Traffic on Inland Waterways

In spite of the immense sums of money that have been expended for the improvement of inland waterways in the United States (probably in the neighborhood of three-quarters of a billion dollars), the total river traffic of the country has steadily decreased, so that at the present time few rivers are used to anything approaching their full capacity. As a matter of fact, the only inland waterways that have not steadily lost ground in recent years are the Ohio River and the Great Lakes. The favorable showing on the Great Lakes is due to the transportation of heavy bulk freight, such as ore, coal and grain; while on the Ohio River an enormous coal traffic is kept up chiefly because barges can be loaded directly from the mines on the upper reaches of that river and its tributaries. On the Mississippi River, which, in pioneer days, was the main connecting link between the communities in the Mississippi Valley and the outer world, the total river tonnage at St. Louis has diminished from 1,332,885 tons in 1886 to 365,920 tons in 1908. The entire commerce of the Mississippi River system, including all tributaries except the Ohio, in 1889 amounted to 12,492,535 tons, while in 1906 it had dwindled to 4,304,288 tons—this in spite of the fact that an 8-foot channel is now maintained from St. Louis to New Orleans, and within a few years a permanent 6-foot channel will be available from St. Louis to Minneapolis. The same, or an even greater, decrease is also found on the canals in the United States. Out of a total of nearly 5,000 miles of canals, more than half have been abandoned.

Generally speaking, the decline of navigation lines on inland waterways is due largely to the natural expansion and legitimate competition of the railroads. The advantages which railroads possess over inland waterways for traffic are clearly set forth by Mr. Walter S. Fisher in a recent issue of the *Journal of Political Economy*. The railroads can provide shorter and more direct routes; they are practically unhampered by climatic conditions; they can provide practically unlimited extensions for the collection and delivery of freight remote from their main lines; a thousand conveniences and economies are possible by using the car unit of the railroads, with which transshipment is cheaper and quicker than transshipment from boat to boat. Another decided advantage of the railroads is their superior administration and organization, and the fact that they practically insure their freight.

Granting these advantages to the railroads, nevertheless there is another side of the question to be considered. Investigations by the Congressional committee on merchant marine and fisheries have produced ample evidence to show that the railroads have successfully opposed the maintenance and development of river and canal traffic by a variety of effective methods, mainly by acquiring competitive water lines and canals, by obtaining control of the terminal facilities, by the use of rebates or by the undercutting of rates. Since the railroads reach all sections of the interior, while the inland navigation lines are restricted to their water course, they can easily control so large a proportion of the total freight as to leave the water lines insufficient freight to maintain proper terminals and efficient service. So large a portion of railway traffic is free from water competition that railways can readily afford to reduce rates on those portions affected by such competition, so as to destroy the profits of the water lines without appreciably affecting the profits of the rail systems, which recoup these reductions by higher rates elsewhere. The Mississippi River, for instance, is paralleled on both sides by railroads. River steamers can still underbid the railroads to some extent on local traffic, but they are at a disadvantage in loading or terminal expenses and in insurance risks, as well as on account of the hazards of navigation due to the varying stages of the river. On the Mississippi, packet line services have for the most part disappeared, owing to the railroad competition, and the same handicap is also found on other large rivers in the country. Most of the canals of the country have also passed into the hands of competing railroads. At present about 90 percent of the mileage of the private canals still in operation is under railroad control.

The decline of river traffic can be laid, of course, to other causes besides the discrimination in railroad rates, although the opposition by the railroads is by far the most important. One of the greatest handicaps to inland navigation is the absence of terminals. On an experimental trip of a thousand-ton, self-propelled steel barge from New Orleans to St. Louis the total cost of loading and unloading the barge on the trip was 63 percent of the gross receipts for the freight carried. No greater obstacle could be placed in the path of transportation than to ignore entirely the question of terminals. In addition to this, the water lines should be linked up with the railroads, so that one will supplement the other without destructive rate wars. Better banking and insurance facilities would also go far towards improving conditions in the improvement of inland navigation, all of which is to be looked for when the general public begins to realize that the navigation of inland waterways is an important economic factor in the transportation systems of the country.

Fig. 1.—River Steamers Assembled at Gallipolis, Ohio, on September 6, to Celebrate Completion of Lock and Dam No. 26 in the Ohio River

Western River Steamers and Barges

Peculiar Requirements for Downstream Towing in "Running" Water—Construction of Towboats and Barges

BY CAPTAIN E. A. BURNSIDE *

In an article published in the November, 1913, issue of INTERNATIONAL MARINE ENGINEERING, attention was called to the prevailing types of stern wheel towboats and the smaller packet boats used on the Western and Southern rivers of the United States, and also to the satisfactory operation and use of this class of boats. Such vessels have been designed and built to meet the exceptional conditions found on the Western rivers of the United States, where the stages of water vary from 12 inches to 70 feet, and where the low water periods range from three to five months of the year. An important requirement for these boats has been low first cost, and for this reason they have hitherto generally been constructed of wood. In the article referred to the statement was made that for downstream towing in the natural current, or "running water" as it is termed, of such rivers as the Ohio and Mississippi and their navigable tributaries, where the widely varying and oftentimes difficult operations of flanking, backing, drifting and quick handling in backing are required, no type of steamer surpasses the prevailing types of the stern wheel towboats.

These stern wheel towboats are built along the same general lines and after the same models that were used forty years ago. Three or four rudders are placed forward of the paddle wheels, which in backing give tremendous twisting power, the immersed part of the three rudders having an area of from 115 to 150 square feet and sometimes up to 175 square feet. These boats are the only types that can successfully navigate these rivers and maneuver and handle the large tows in running water.

Of course there have been improvements consisting of refinements in the construction of hulls, engines and boilers, and in the use of new labor-saving machinery. Tandem compound condensing and non-condensing engines have been used in place of the simple high-pressure engines. Refrigerating plants and steam steering apparatus have been introduced. Sanitary drinking fountains, providing cold water for the crews, filters for the drinking water, electric lights and searchlights have been provided. Improved furnaces have been made and several types of both watertube and firetube boilers have been designed, but, nevertheless, the same general lines of design that were in vogue forty years ago still prevail to a great extent, and many of the older boats built thirty-five years ago are doing splendid service to-day at a comparatively low operating cost, using the old style high-pressure engine.

For packet service also these stern wheel boats leave little room for improvements in their handling qualities in getting in and out of difficult and shallow landings. A friend of the writer, recently manager of a steamboat company operating a line of about fifty steamers on the Amazon River in Brazil, has had an opportunity to observe the performance of this class of steamers, principally stern-wheelers built in various countries—some in Holland, some in France, some in England and some in the United States. The stern-wheelers which this company had in service were the most satisfactory and most efficient of all the vessels they owned, and the manager of the company is responsible for the statement that the American-built boats were superior to any of the others

* Member Society Naval Architects and Marine Engineers and member National Board Steam Navigation.

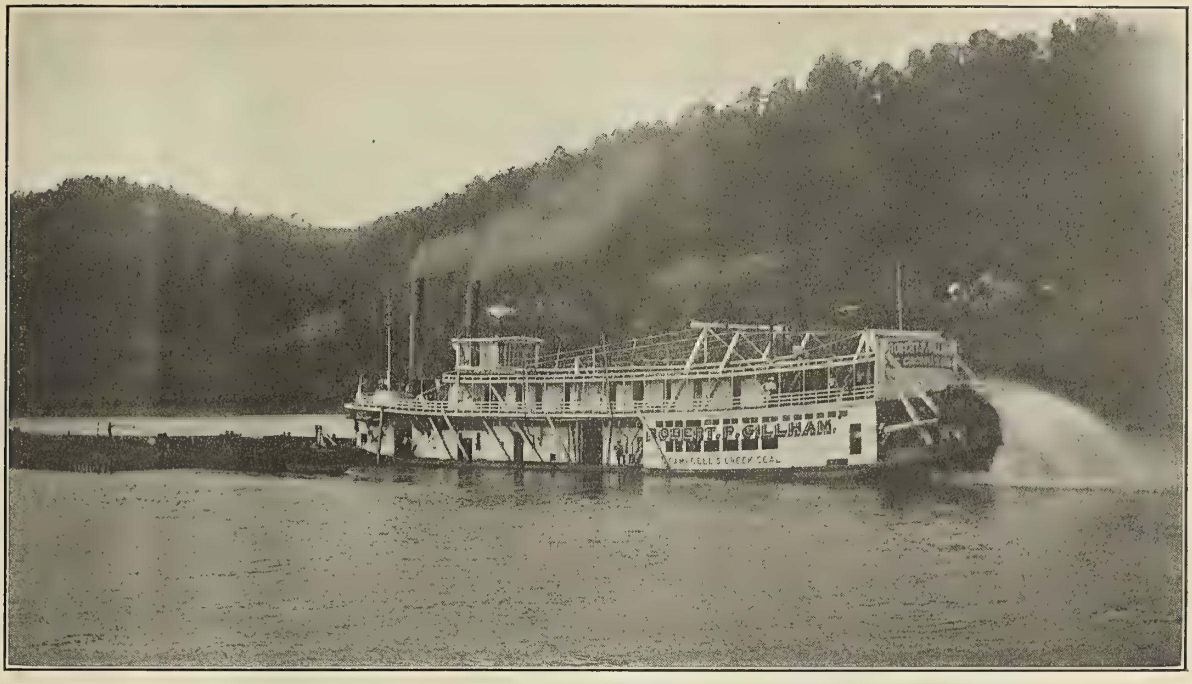


Fig. 2.—"Pool" Type Towboat *Robert P. Gillham* under way with tow of barges

in points of general maneuvering and handling, balance, proportion and in power when the boats were compared ton for ton. This does not mean that the American boats were better built or stancher, but there is a certain quality in their design and the disposition of the boilers and machinery that give them a decided advantage over the other boats.

These boats were designed and built by men who have built many river boats for service on the American rivers and by men who were practical river navigators themselves and knew exactly what was needed to make the boats thoroughly suited for the work. Besides the personal experience which these builders had obtained from observation of the construction of many other boats during their generation, many of the builders came from families whose fathers and grandfathers were engaged in the construction of the same general type of stern and side wheel river boats, and invariably information and traditions were handed down from generation to generation in these firms, culminating in unrivaled excellence in the design and construction of such boats.

Although the Amazon boats referred to above were built for passenger and freight traffic, and this article applies particularly to the stern wheel towboats, nevertheless the same type of stern wheel boats are built for service on rivers in all parts of the world with certain changes in design to suit the conditions obtaining on the various rivers. One firm of American boat builders has stern

Fig. 3.—Large Passenger and Freight Steamer *Virginia.* Insert Shows the *Virginia* Stranded in a Corn Field, 200 Feet from the River, Illustrating Hazards of Navigation on Western Rivers. The Vessel Was Later Floated Again and Resumed Her Service on the River

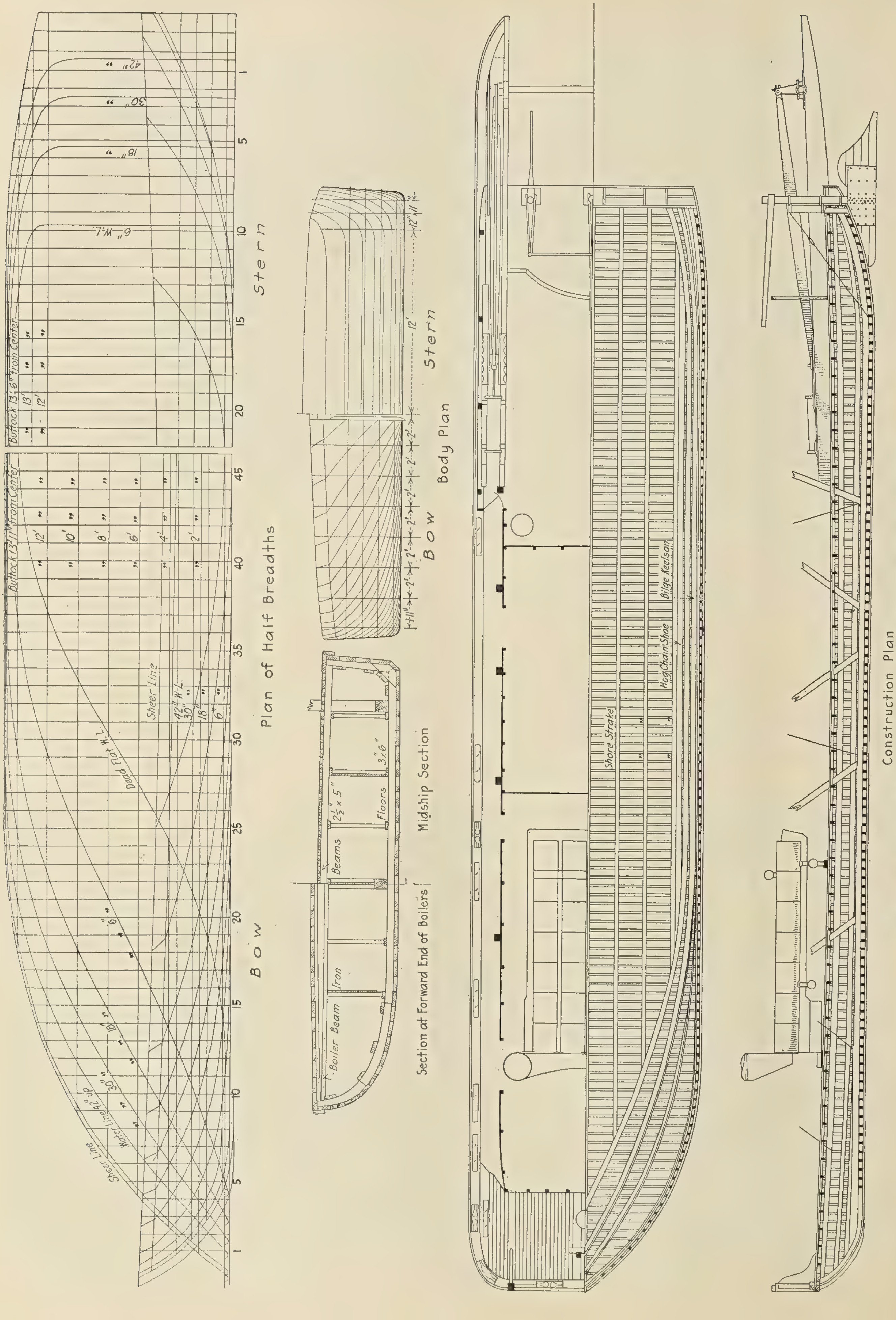


Fig. 4.—Lines and Construction Plans of Wooden Sternwheel Towboat

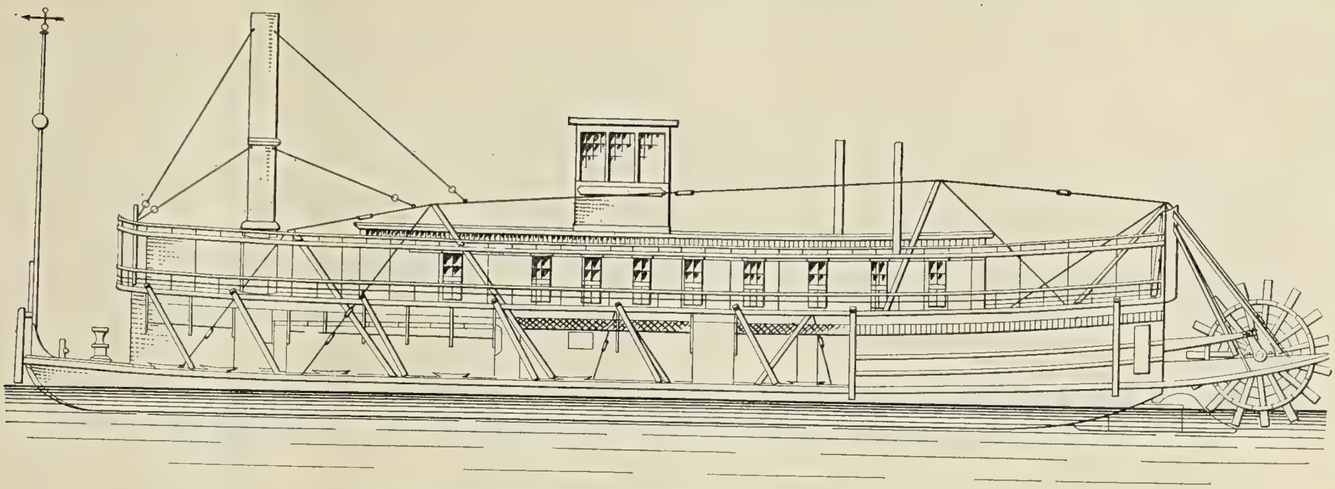


Fig. 5.—Outboard Profile of "Full-Roofed" Sternwheel Towboat

wheel boats of their construction on most of the navigable rivers of the world except possibly the rivers of Central Europe and England. The same can be said of the American-built stern wheel towboat. In the writer's opinion nothing better can be designed for towing on any rivers where shallow draft hulls are used and where the conditions of service are similar to those on the American Western rivers—that is, for handling large tows downstream in running water.

There are two general types of stern wheel towboats in use on the Western rivers. This general classification applies mainly, however, to their structural appearance. The smaller type is made with the pilot house down on the boiler deck in front of the cabin, and is known as the "pool boat" type. This construction is adopted so that the boat can go under low bridges as contrasted with the regular type of towboat with full roof, with the pilot house on top of the hurricane deck, from which the pilot can have a clear view both forward and aft. The higher elevation of the pilot house on the regular towboats is also an added advantage to the pilot in that he can pick out the channel more easily, note the changes in sand reefs more quickly, and at the same time have a better view of his tow and the shores of the river, etc. Probably the most efficient and powerful of the smaller class of full-roof towboats is the stern wheel, steel hull steamer *Slack Barrett,* completed in 1914 and fully illustrated and described in the November, 1914, issue of International Marine Engineering. This steamer has a scow bow in place of the usual model bow, and was designed by her owner, Captain O. F. Barrett, for special work. This boat more than fulfills all the expectations of the owner and builders.

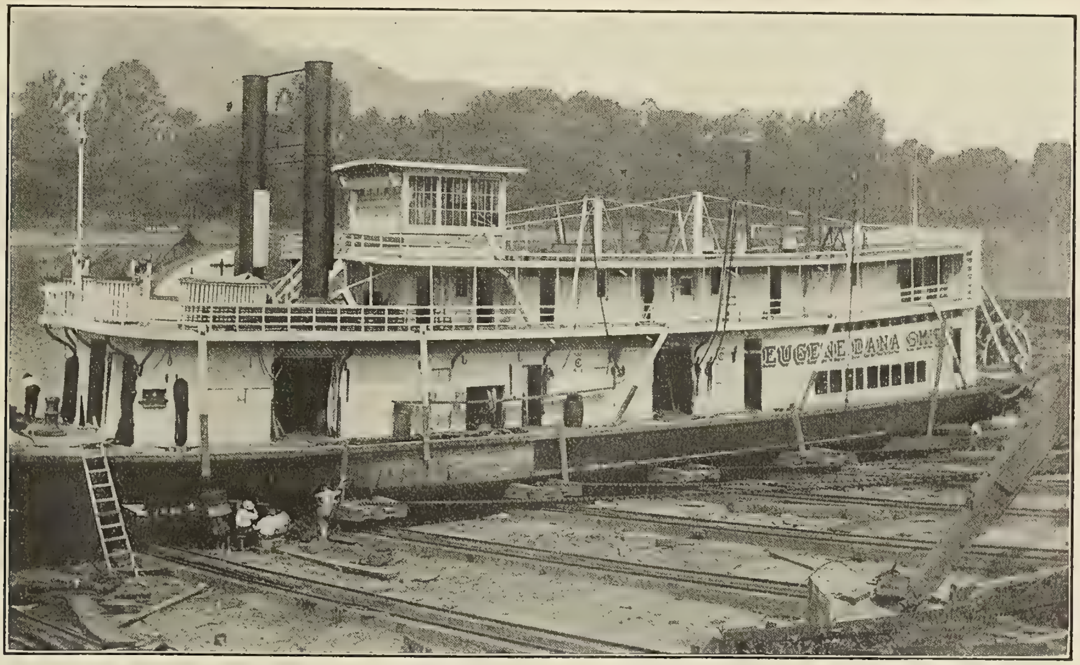


Fig. 6.—"Pool" Boat Type of Sternwheeler on Ways for Repairs

Many people are under the impression that the ordinary paddle wheel used on Western river towboats and sternwheelers generally revolves or turns in a very sluggish manner. Fig. 2 shows a typical stern wheel towboat going down the river with her wheel turning at about 22 revolutions per minute with a tow ahead of 16 barges of 550 tons each. The wheel on this boat is 22 feet long, 19 feet diameter, with buckets 31 inches wide. The wheel shaft is a Bethlehem nickel steel hollow forging with cast steel cranks, flanges, etc. The weight of the wheel shaft

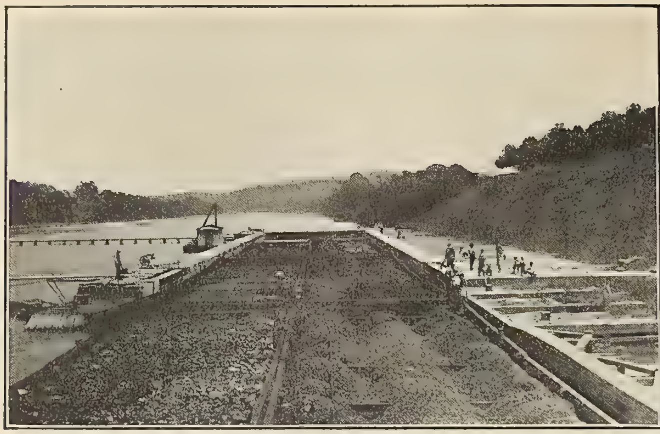


Fig. 7.—Coal Barges in Lock Chamber at River Dam

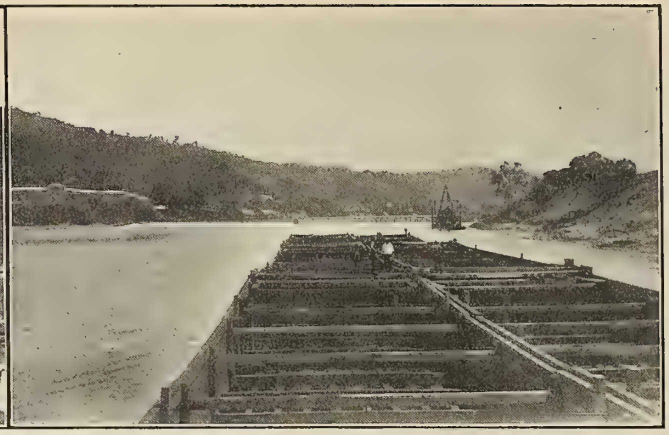


Fig. 8.—Empty Barges Approaching Lock and Dam

with fittings is 16,000 pounds, while the weight of the wheel complete is 36,000 pounds. The center of the wheel shaft bearings is 13 feet from the hull.

Until a few years ago the low cost of wooden boat construction was the principal reason for building nearly all Western river tow and packet boats of wood, but at the present time the increasing cost and scarcity of good boat timber are causing a change, and probably one-third, or at least 25 percent, of the recent boats are built of steel. Formerly but few boat-building plants along the rivers could turn out steel or iron boats, and there were few men who could design and build anything except a wooden boat. Now, however, there are a number of large shipbuilding plants located on the Western rivers where vessels of any ordinary size can be built of steel. Prominent among these firms are the James Rees & Sons Company, Pittsburgh; the American Bridge Company, Pittsburgh; E. J. Howard, Jeffersonville, Ind.; the Charles Ward Engineering Works, Charleston, W. Va.; Charles Barnes Company, Cincinnati, Ohio; the Dubuque Iron Company, Dubuque, Iowa, and others. Now that the river men are realizing the increased value and the greater length of service with greater safety of steel boats when built with compartments, the former high first cost is discounted and the greater life of the steel boat makes the cost in the end much cheaper.

Another great advantage of the steel boat is that it never becomes waterlogged—that is, it does not get heavier with age, as is the case with wooden hulls, and the draft of the steel boat when first built is her draft ten years later, whereas the draft of a wooden boat in ten years would increase approximately 15 to 20 percent. Moreover, the steel boat will keep its shape and sheer with little or no hog-chaining and will stand more severe shocks and collisions with rocks and snags with much less damage than is the case with the wooden boat. These advantages all make the steel boat far cheaper than a wooden boat, and the cheaper first cost of the wooden boat is eliminated in two or three years, the steel boat then showing its value and stability.

Wooden towboats equipped with boilers and engines ready for steam, but not including cabin and deck equipment, lines, syphons, syphon rigging, chains, wires, etc., cost at the present time about $200 (41/13/4) to $250 (52/1/8) per net registered ton. Wooden passenger and freight boats cost from $150 (31/5/0) to $225 (46/17/6) per net ton. The greater cost of the towboat construction is accounted for in the heavy timbers used and the greater strength required, as well as the much heavier power plants which are necessary on the towboats. Some very light wooden packet boats have been built as low as $125 (26/0/10) per net ton.

Steel hull construction will not cost much more than wood when consideration is given to the greater safety and strength of the steel hull. As previously stated, the higher first cost is eliminated in a few years. The life of a wooden boat rebuilt once or twice is about twenty years. On the other hand, the steel hull with proper care and painting

Fig. 9.—U. S. S. *Inspector*, Twin-Screw Tunnel Towboat Built by the Ward Engineering Works, Charleston, W. Va.

Fig. 10.—A River Tow in Lock Chamber

Fig. 11.—Blockade of 120 Barges and 3 Towboats in Kanawha River at Point Pleasant, W. Va.

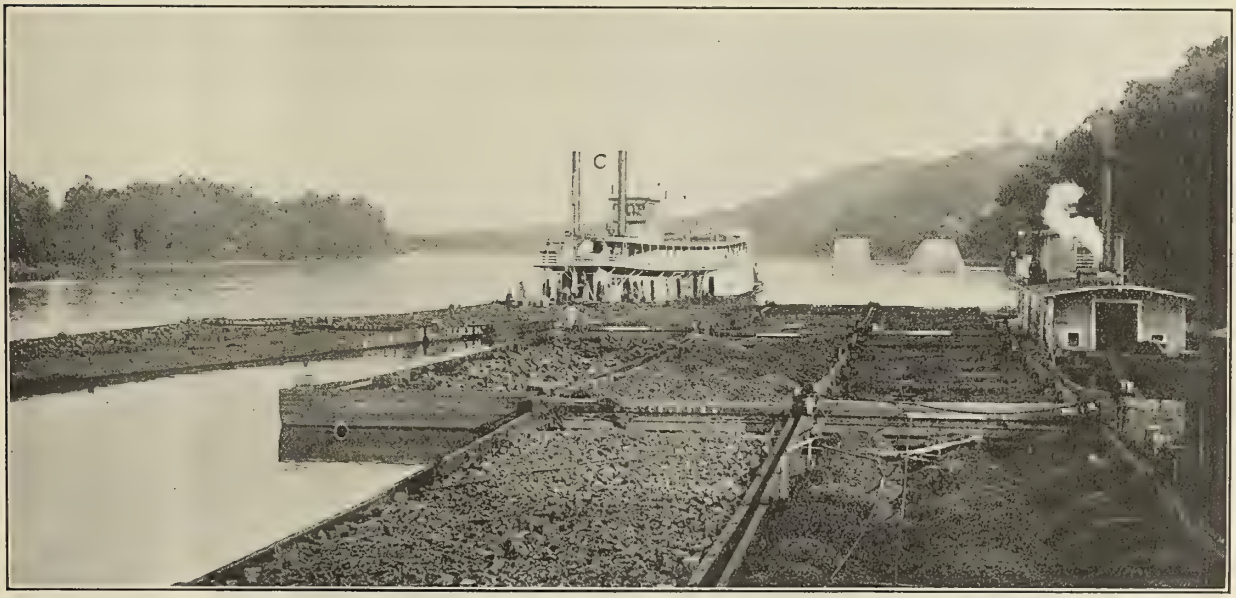


Fig. 12.—Towboat Landing at Mouth of Kanawha River, Where Large Tows Are Made Up to Go Down the Ohio

Fig. 13.—Loaded Tow Bound Downstream. View from Pilot House of Towboat

and with no disastrous accidents will last forty years or more. The cost of the best class of steel towboat construction, equipped with tandem compound condensing engines, cylindrical two-flue boilers, electric lights, steam steering gear, wooden cabin and upper works, but without cabin and deck outfit, will run from $300 (62/10/0) to $350 (72/18/4), while steel passenger boat construction, with tandem compound engines, non-condensing, with wood cabins and upper works, electric lights, steam steering gear and small refrigerating plant, but with no outfit, will run from $250 (52/1/8) to $300 (62/10/0) per net ton. With steel towboats with improved tandem compound condensing engines, horizontal two-flued boilers, steam steering gear, electric lights, filters, refrigerating plant, etc., the machinery cost is about one-half the entire cost of the vessel, unless the boat is of more than the ordinary size of hull. In the ordinary wooden towboats the machinery cost, including boilers, steering gear, electric lights, etc., will run about two-fifths of the cost of the vessel. The difference in cost between the wood and steel hull construction will run about 33 to 60 percent more for the steel, owing to the general construction problems, weights of material, etc. The tonnage given above is the United States Custom House tonnage and not the deadweight or displacement tonnage of the boats.

Effect of Changing Conditions on Navigation

While in the opinion of the writer the regular stern wheel type of towboats will never be surpassed for downstream handling of large tows in running water, or in a current on shoal water, where flanking and other operations are required, nevertheless conditions are changing at the present time with the complete canalization of the upper Ohio from Pittsburgh to Louisville. In a few years the whole of the upper Ohio and all its main tributaries will be improved with locks and dams and we will then have slack water navigation in the late spring, summer and fall months. Under these conditions, it is probable that boat owners and coal shippers will find another type of towboat especially designed for use in "pool" waters—that is, rivers where the water is dammed and use is made of the locks. When this is brought about, there will be a good stage of water in the rivers between the dams with little or no current, so that the peculiar advantages of the stern wheel type of towboats for running water navigation will not be required. Flanking and other qualities peculiar to the stern wheel boats will not be essential in slack water, nor will the tows be as large as at present, as they will be limited to the capacity of the locks. On the other hand, more ahead steerage power will be required, and this cannot be supplied by the stern wheel boat without frequent stops to back and twist, and with little or no current flanking will not be required.

The probable partial successor to the stern wheel boat for slack water tow navigation will undoubtedly be the twin screw tunnel type of towboat, and during the next few years it is very probable that improvements will be made in the design of both hulls and machinery for the tunnel type of boats, especially fitting them for this class of towing and other special work. They will be much cheaper in operating costs, both in the wages of the crew and consumption of fuel. Greater ahead steerage power will be supplied by these twin screw tunnel towboats with part of their rudders aft of the wheels to get the full force of the stream of water from the wheels. The builders of this class of boats are making decided and rapid progress in their designs and important results can undoubtedly be looked for in the future.

The engines to be used on the twin screw tunnel towboats will be of the vertical or other type of compound and triple expansion engines of high speed with specially designed boilers with the horsepower running from 700 to 900. In spite of this, however, let it be said that the old type of stern wheel tow and packet boat will be used for many, many years, and those of us of the old school of towboat men cannot see how any vessel can be designed to surpass the old stern wheel towboat for handling large tows down stream in running water. The tows of the larger towboats vary from eighteen to thirty barges, and as these boats navigate in heavy ice and drift, the big wheels of these towboats break up the smaller drift logs and also break up large ice floes so they can back through them with remarkable effectiveness. This is done usually with but little damage to the wheels; and even if the wheels are broken, material is carried on the boats to make immediate and speedy repairs. This is frequently done while the boat is floating or drifting with the current.

Troubles with River Boat Boilers

The question of boilers is a serious one for Western river boat owners. The old style horizontal flue boiler generally used, while remarkably effective as a steamer and cheap in first cost, is by no means the ideal boiler, nor has a satisfactory boiler as yet been produced for this service that will be reasonable in first cost and effective under all the various severe conditions which prevail. There are, however, two or three types of watertube boilers that are far in advance and much more effective than the older types of watertube boilers, and it is very probable that the builders, constantly gaining by experience, will devise a watertube boiler that will successfully meet the conditions imposed on river boilers. Some of these boilers, notably the Ward and Kidney, have shown some remarkable performances and are in constant use, but so far the typical Western river man sticks to his old horizontal flue boiler.

The greatest trouble with the externally fired river boat boiler, especially those used in the upper Ohio, where the water is especially bad and strongly acid, is the fire cracking of the edges of the overlapping shell plates and the corrosion of the plates by the acids and other deteriorating substances in the waters during the low water season. The boiler plate maker who can produce boiler plates of such qualities as will greatly reduce the fire cracking and corrosion will have gained the gratitude as well as the business of all river boat owners. One of the master mechanics in a big company owning a number of towboats had numerous experiments made at one of the big plate mills, using a copper alloy in the manufacture of the plates with such satisfactory results that finally he has given the mill a large order for plates of this material.

On account of the height of the elevation at which the river boat boilers must be placed above the deck, no satisfactory mechanical stoker fully adapted for use on river steamers has as yet been designed. The varying and exacting conditions under which river boilers are used apparently will make it difficult to design such a stoker that will do its work in a satisfactory manner.

The wooden coal barges generally used for transporting coal and other heavy bulk material on the Ohio and Mississippi and their tributaries, principally the Monongahela and Kanawha, were formerly constructed of white pine from the Allegheny River pine forests, but owing to the scarcity of good, long-length pine and its increasing cost, these barges are now for the most part built of Oregon and Washington fir brought by rail to the builders' yards from the Pacific coast, and at a remarkably low cost, too. The firm with which the writer is connected is building these coal barges of an approximate carrying capacity of 550 tons of this Oregon and Washington fir at about the same

Fig. 14.—Hull Nearly Completed

Fig. 15.—Framing of Hull

Fig. 16.—Hull with Superstructure Just After Launching

Fig. 17.—Main Deck

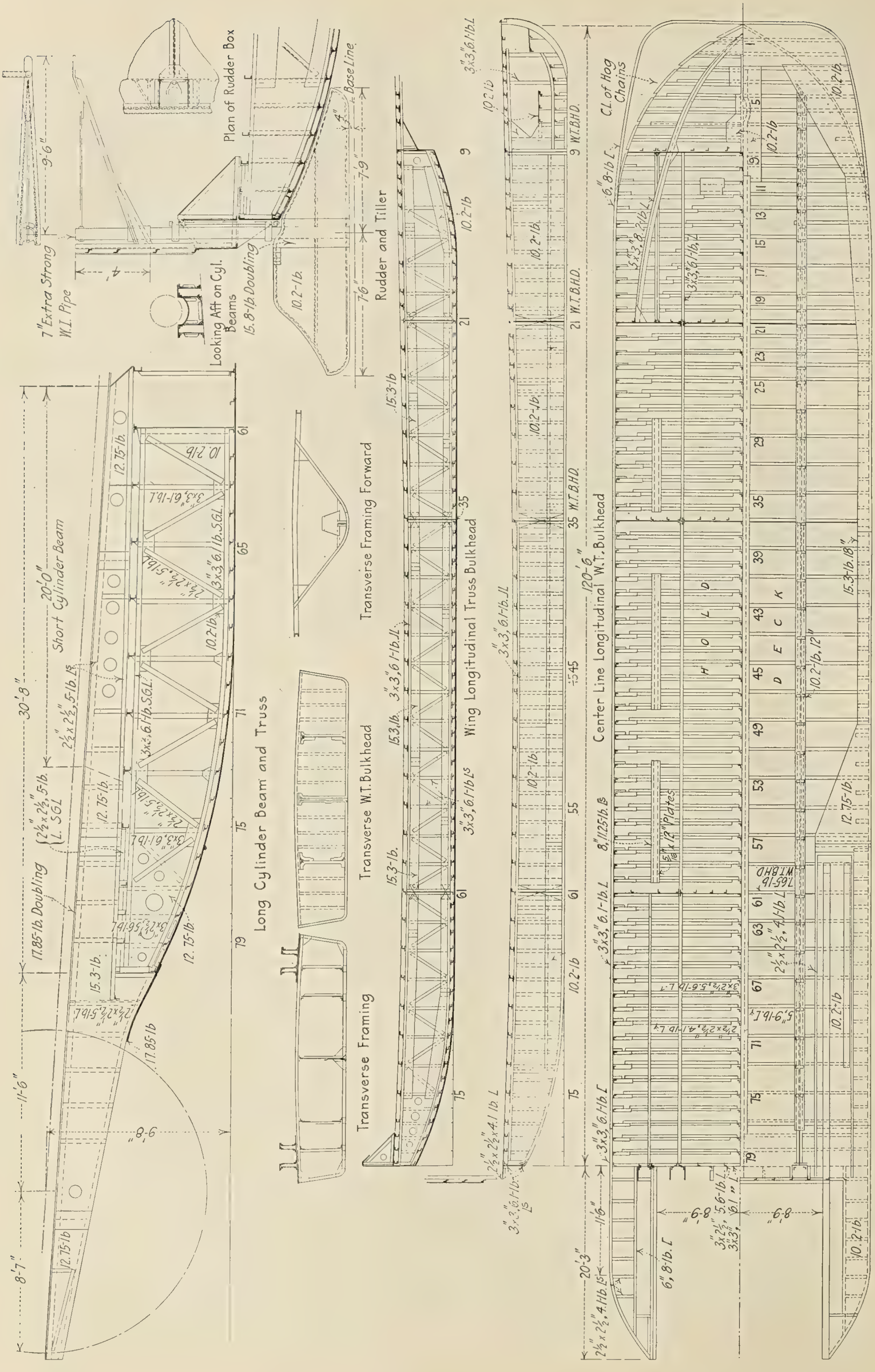
Fig. 18.—Putting the Machinery on Board

Fig. 19.—The *Homer Smith* Completed

Views Showing Construction of Magnificent River Excursion Steamer, Licensed to Carry 2,800 Passengers

cost as was paid for the white pine barges some ten to twenty years ago. A 550-ton barge costs approximately $20 (4/3/4) per net ton empty displacement, although they can be built with a little lighter timbers and less iron and calking for from $17.50 (3/12/11) to $18 (3/15/0) per net displacement ton. Many of the 750-ton barges are now being built of fir with the bottom gunwales of full length 125 feet in one piece at a cost of approximately $19 (3/19/2) to $20 (4/3/4) per net displacement ton empty. The 550-ton barges are 135 feet long, 26 feet wide, 8 feet deep and displace when light about 100 tons. The 750-ton barges are the same size overall but 9 feet deep and displace about 110 tons. In a wood barge, when the material is at hand, about six days are required to construct and launch one of these barges, although they have been built and launched in less than five days. In the 550-ton barges there are about 43,000 feet of timber, board measure, about 350 pounds of oakum, 150 pounds of cotton and several tons of spikes, bolts and bands. The average life of these barges is from twelve to fourteen years.

Steel barges will later come into more general use. The cost of steel coal barges of the same size as the wooden ones described above runs from $45 (9/7/6) to $55 (11/9/2) per net displacement ton. Steel freight barges with cargo house on the deck cost from $65 (13/10/10) to $75 (15/12/6) per net displacement ton and carry from 1,000 to 1,200 tons of freight. With the exception of the freight barges, these steel barges are all



Half Plan of Hold and Half Plan of Deck

Fig. 1.—Construction Plans of Steel Government Sternwheel Towboat *Warioto*

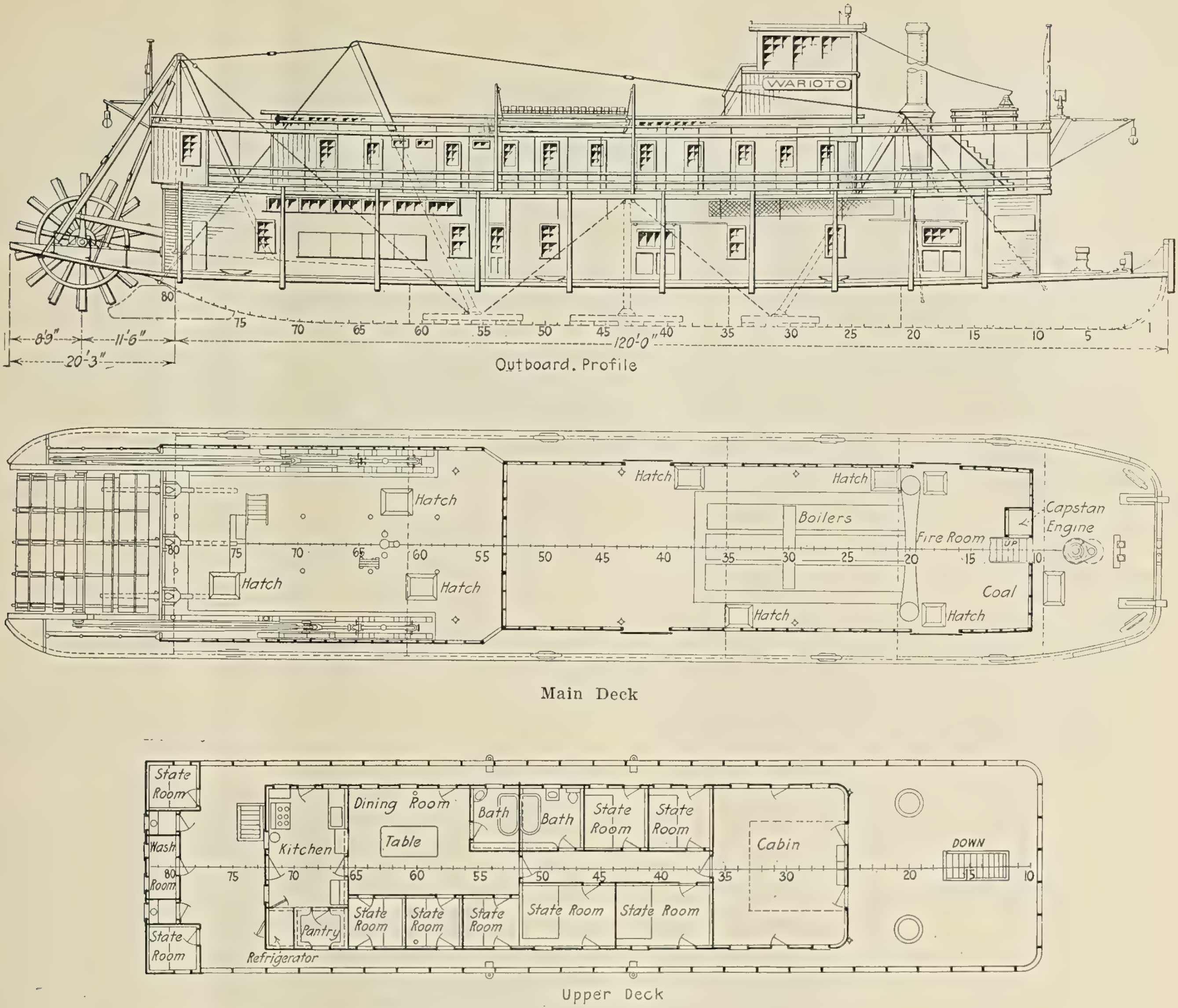


Fig. 2.—Profile and Deck Plans of the *Warioto*

of the open type, with no decks and with no compartments except at each end.

One of the largest and finest passenger and excursion steamers yet built on the Western rivers is the *Homer Smith,* illustrated in Figs. 14-19. She is owned by the Security Steamboat Company of Point Pleasant, W. Va., and is 272 feet extreme length over the wheel, 50 feet beam over guards, 7 feet depth of hold, about 760 tonnage, 1,100 horsepower, and is capable of speed upstream in the Ohio of 13 miles per hour. Her carrying capacity is 2,800 passengers. She is built of white oak and is propelled by two sets of tandem compound, non-condensing engines 16 and 28 inches diameter by 96 inches stroke, with variable cutoff poppet valves, steam ram and inside cam gear, all of Marietta make. The wheel shaft is of forged iron of hexagon shape, 12 inches diameter at the center, 11½ inches diameter at the journals and 32 feet long. Steam is supplied at 221 pounds gage pressure by five horizontal two-flue boilers 40 inches inside diameter and 30 feet long. The boat is equipped to carry passengers on long trips and is provided with removable as well as stationary staterooms. A large refrigerating plant, cold storage room and duplicate electric lighting plants are installed. The cost of the boat completely equipped was $115,000 (£23,600).

Government Towboat Warioto

The Dubuque Boat & Boiler Works have recently completed the two stern wheel towboats *Warioto* and *Comanche* for the U. S. Engineers. The *Warioto* is for the Nashville, Tenn., office, and is working on the Cumberland River. The *Comanche* is for the Chicago office and is to be used on the Illinois River Improvement.

Both boats are of the following dimensions:

Length between perpendiculars	120 feet
Length over fantails	141 feet
Beam, molded	27 feet
Depth at side	5 feet
Crown of deck	6 inches
Draft with 30 tons coal aboard	3 feet 8 inches
Displacement at 38½ inches waterline	246 short tons
Block coefficient	0.78

The hull is of steel and is divided into nine watertight compartments by one centerline watertight bulkhead and four transverse watertight bulkheads. There are two longitudinal trusses 6 feet 6 inches each side of the centerline, and under each cylinder beam there are fitted trusses as shown on plans.

The hull is chained by means of a system of columns and rods. The main columns are 6-inch channels latticed set-

ting on a foundation of 8-inch, 11.25 pounds channels. The main chains are 1½-inch rods with standard turnbuckles. The wheel chains are 1⅛-inch and 1¼-inch chains or rods with standard turnbuckles. The arrangement is clearly shown on the accompanying drawings.

The flat plate keel is of 12.73-pound plate extending the entire length of the hull. The stem is 6 inches by 1½ inches, rounded on the forward side, terminating in a club foot to receive the forward keel plate. The main transom at the stern on frame No. 80 is 15.3-pound plating secured to the shell and deck plating by 3-inch by 3-inch by 6.1-pound angles. A false transom is fitted 18 inches aft of the main transom and is of 3/16-inch plating bound by 3-inch by 6.7-pound Z-bars, and is carried by means of

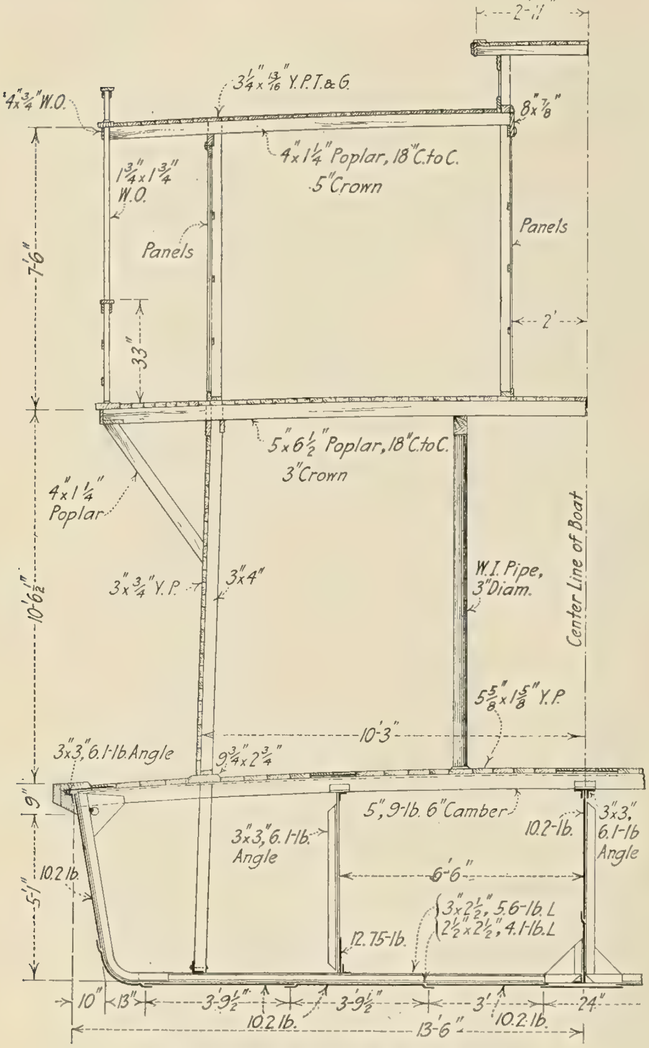


Fig. 3.—Midship Section, S. S. *Warioto*

10.2-pound brackets from the main transom and extension of the rudder wells. The floors, spaced 18 inches throughout, are of 3-inch by 2½-inch by 5.6-pound angles, with 2½-inch by 2½-inch by ¼-inch reverse angles.

The transverse bulkheads, which are on frames 9, 21, 35 and 61, are intercostal to the centerline bulkhead and are built of 7.65-pound plates with bounding angles 2½ inches by 2½ inches by 5 pounds, stiffened by 3-inch by 2½-inch by 5.6-pound angles spaced 19 inches between centers. The centerline bulkhead, extending from frame 9 to the aft transom, is built of two strakes of 10.2-pound plate, with top and bottom angles 2½ inches by 2½ inches by 5/16 inch. Stiffeners of 3-inch by 2½-inch by 5.6-pound angles are located at each frame.

Bilge stringers of 5-inch by 3-inch by 8.2-pound angles are fitted on each side of the bow from the stem to bulkhead 21. The deck beams are 5-inch by 9-pound channels spaced as shown on the plans.

There are three boilers built for 200 pounds working pressure, of the externally fired Western river steamboat type, 40 inches diameter by 24 feet long, having three 9-inch flues and three 6-inch flues. The grate area is 48 square feet and the heating surface 1,365 square feet.

The auxiliaries include a main and auxiliary feed water heater, a "doctor" feed pump and an auxiliary Blake & Knowles pump, a double barrel steam capstan on the forward deck, a 7½-kilowatt electric generator driven by a Terry steam turbine and a Gardner improved type steam steering gear.

On the speed and evaporation tests of the *Warioto,* the main engines developed an average of 304 indicated horsepower, 26.9 pounds of dry steam being required per indicated horsepower per hour for the main and auxiliary engines. The pounds of dry coal per indicated horsepower per hour figured out as 4.1.

Mississippi River Excursion Steamer Idlewild

One of the few stern wheel steamers built in recent years exclusively for excursion and packet service on the Mississippi River is the steel hull steamer *Idlewild,* constructed by James Rees & Sons Company, Pittsburgh, for the West Memphis Packet Company, which operates excursion and ferrying steamers out of Memphis. The *Idlewild* is engaged five and one-half months each year in the excursion business and six and one-half months as a

Fig. 1.—Stern View of the *Idlewild*

day packet between Memphis and Beacon Point, Ark., 35 miles out of Memphis. On this route the vessel leaves Memphis at 8.30 every morning, returning at 6.30 in the evening, carrying both freight and passengers.

The dimensions of the *Idlewild* are: Length, 160 feet; beam, molded, 40 feet; floor, 35 feet; depth of hold, 5 feet. Steam is supplied by three boilers, 44 inches diameter and 24 feet long, with seven flues each. The main engines have cylinders 16 inches in diameter by 6 feet 6 inches stroke. The vessel has a fine large cabin arranged for dancing and a "texas" cabin for the crew.

Motor Boat Kern

The steel river boat *Kern* illustrated on page 489 was recently completed by the Moore & Scott Iron Works, San Francisco, Cal., for the Union Oil Company of California, to be used on the Sacramento and San Joaquin

Fig. 2.—Excursion and Packet Steamer *Idlewild*, Built by Jas. Rees & Sons for the West Memphis Packet Company

rivers for delivering refined oils from their plant at Oleum. The *Kern* is 129 feet overall, 28 feet beam and 6 feet molded depth.

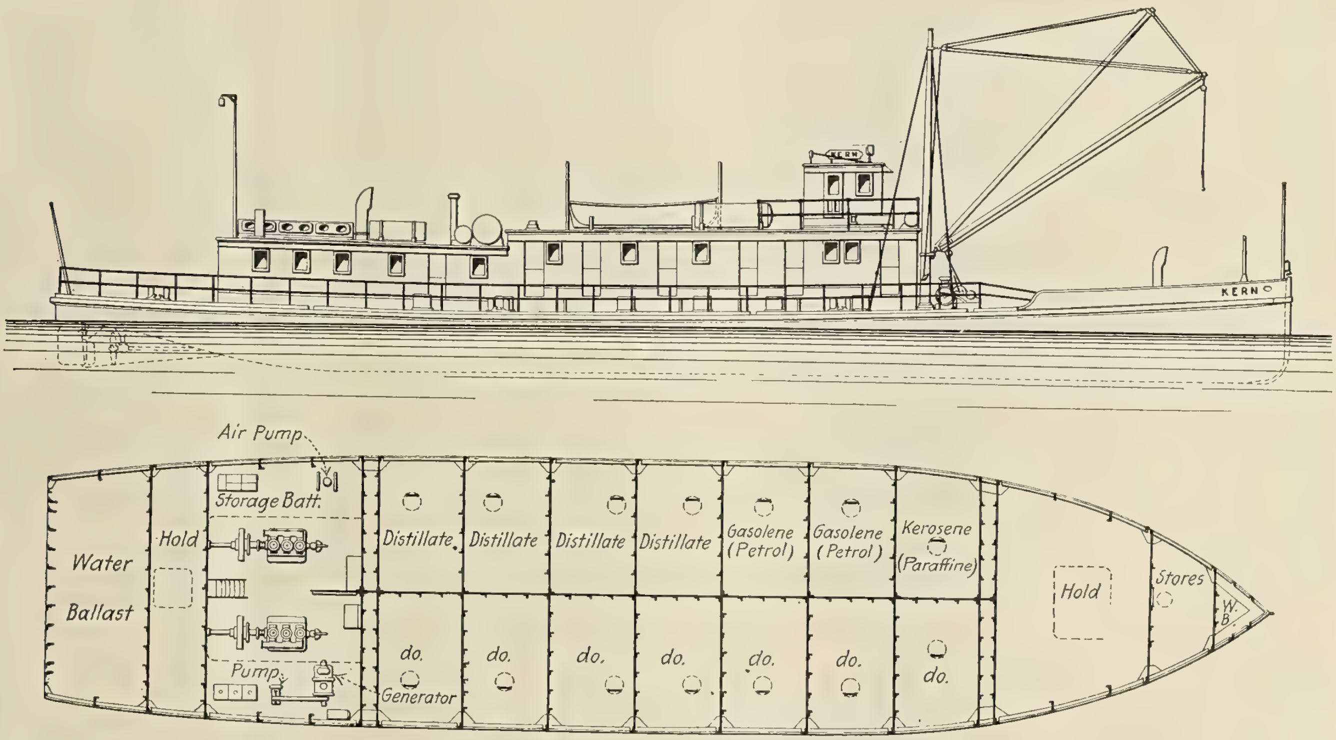
The hull is built of steel throughout with the exception of the bottom, which was of iron to the turn of the bilge. This was done on account of the excessive wear on the bottom of the boat, due to the fact that she must be grounded on sand bars in delivering her cargo, iron being considered as having better wearing qualities than steel for this scouring action.

The hull is divided into twenty-two compartments, fourteen compartments being used for refined oil, the forward and after peak tanks being used for trimming the boat when light. The cargo tanks carry 30,000 gallons distillate, 20,000 gallons gasoline (petrol) and 10,000 gallons coal oil. Also 10 tons of cargo are carried in the forward hold, on a maximum draft of 5 feet.

Propulsion is supplied by two Meitz & Weiss reversible oil engines of 75 horsepower each. The propellers are 43 inches diameter by 40 inches pitch, running at 320 revolutions, giving the boat a speed of 8.4 knots.

The auxiliaries are composed of a 2-horsepower Fairbanks-Morse gas engine direct connected, a 3-horsepower Meitz & Weiss oil engine, driving on air pump, and a 6-horsepower Union gas engine hoist on the forward deck for hauling cargo from the forward hold.

For handling the bulk oil there is a 20-horsepower Union gas engine and four No. 1 Ramsay rotary pumps, running in pairs, connected to the engine with silent chains and operated with clutches on the engine shaft.



Union Oil Company's Twin-Screw Motor Barge *Kern*

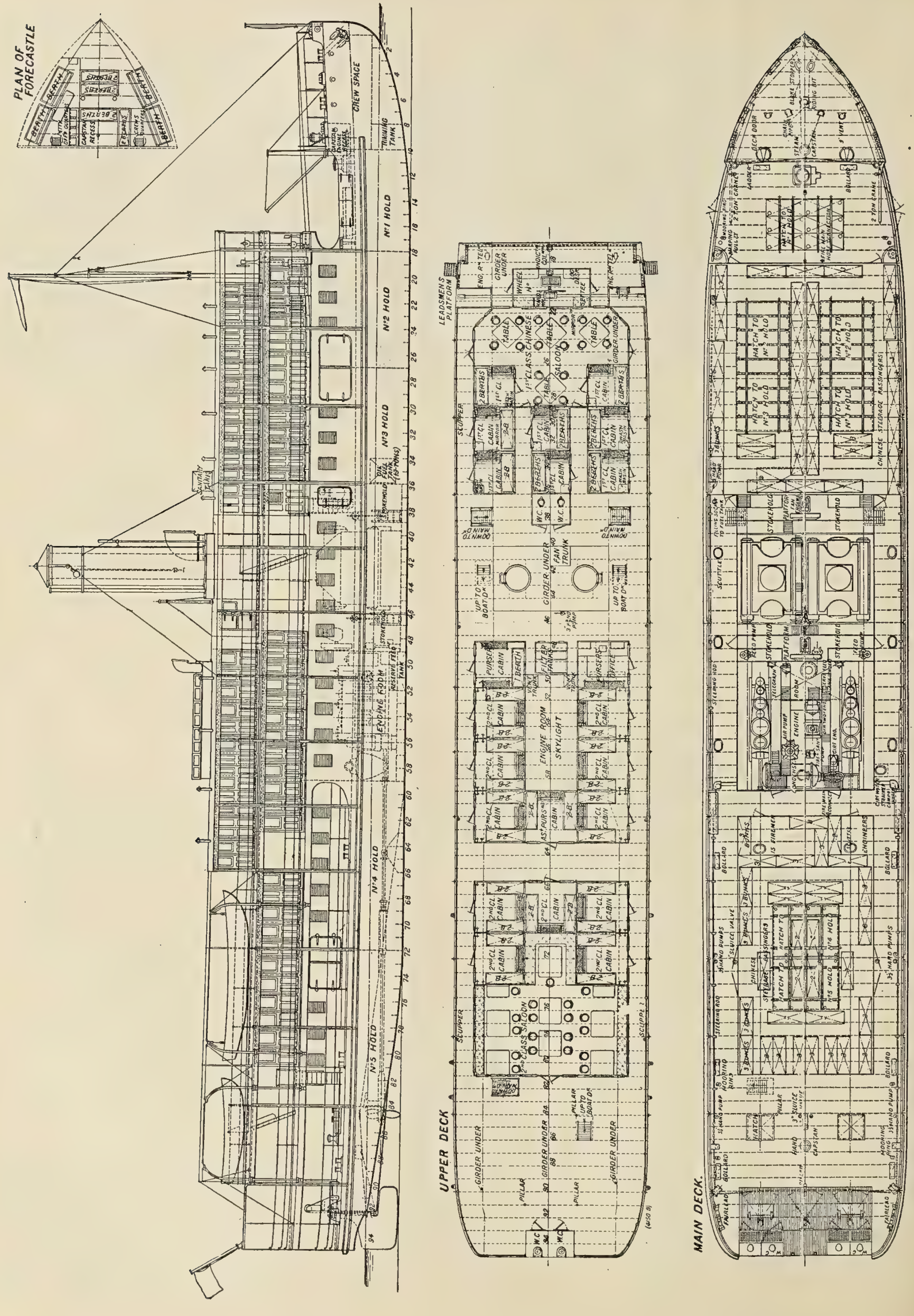


Fig. 1.—Twin-Screw, Shallow-Draft Steamer *Shu-Hun*, for the Yangtse Kiang, Constructed by Messrs. Yarrow & Co., Ltd., Scotstown, Glasgow. (Reproduced from *Engineering*)

Shallow Draft Boat for the Yangtse Kiang

Twin Screw Steel Vessel Built with Tunnel Type Stern Fitted with Yarrow Patent Adjustable Flap

In recent years Messrs. Yarrow & Co., Ltd., Scotstoun, Glasgow, has built a great many shallow draft steamers, most of which have been constructed on the Yarrow principle of screws working in tunnels, the after part of the tunnel consisting of a movable patent flap which can be adjusted to correspond with the draft of the vessel and maintain a solid stream of water for the propeller to work in. One of these vessels which has proved very successful is the *Shu-Hun,* built for the Szechuan Steam Navigation Company for passenger and cargo service between Ichang and Chungking, on the Yangtse River. The builders have furnished us with the following details of this vessel, taken from *Engineering*:

The *Shu-Hun* was built to the special designs of Captain S. C. Plant, one of the best-known navigators of the river, and with many years' experience on this particular part of the great inland waterway. His aim was to produce a vessel sufficiently large and powerful to negotiate the rapids under her own steam without the assistance of warps. To achieve this end it was also necessary that the steering capabilities should be such that there was no possibility of the bow being slewed round when entering the rapid. At the same time it was desirable that the vessel should have sufficiently good passenger and cargo capacity to enable her to be a financial success.

It was finally decided that a length of 190 feet and a beam of 30 feet was the largest size vessel which could safely navigate the rapids on a draft of 5 feet when the load of cargo was 300 tons, and the *Shu-Hun* was accordingly built to these dimensions, and with machinery of 2,000 indicated horsepower.

The general features of the design of the *Shu-Hun* are clearly shown on the drawings. The hull is divided into nineteen compartments by transverse and longitudinal bulkheads, and watertight doors are also fitted to the bunker bulkheads, as damage to the hull of vessels on this river more frequently occurs at the turn of bilge than on the bottom of the vessel. There are four decks in all—namely, main deck, upper deck, boat deck and awning deck. The accommodation for European passengers and the officers is on the boat deck. The accommodation on the upper deck is for the Chinese first and second class passengers. On the main deck there is accommodation for

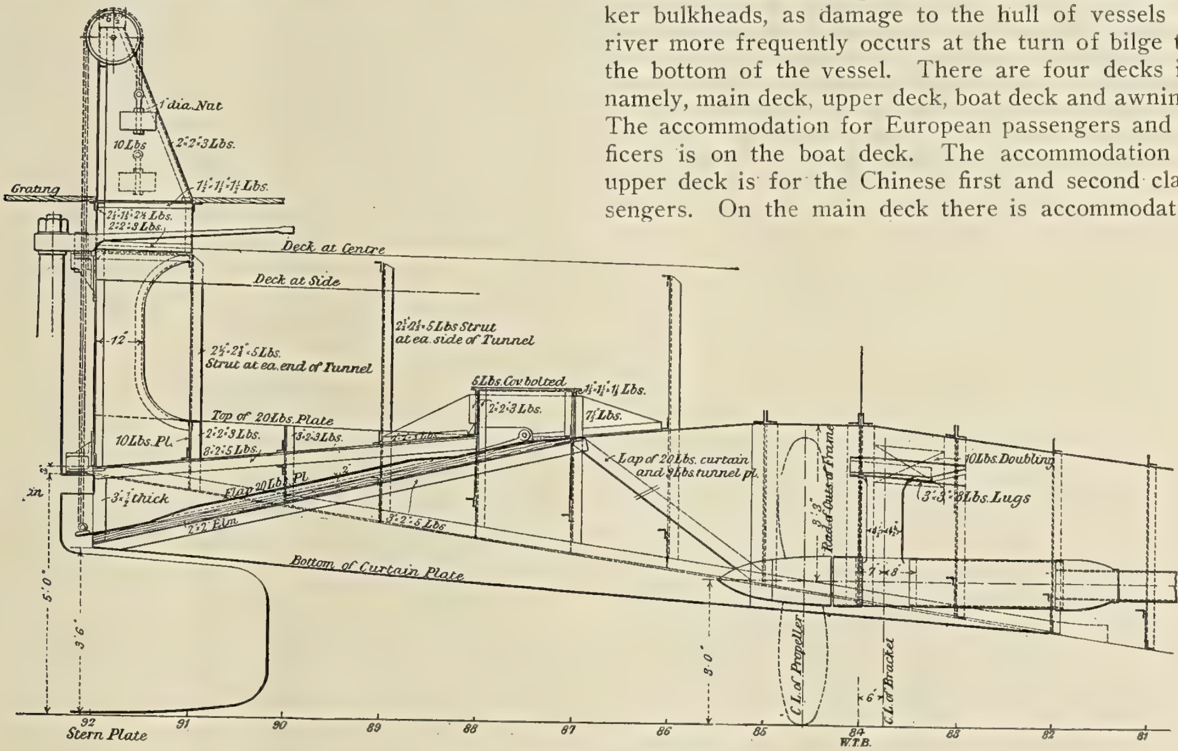


Fig. 2.—Stern of the *Shu-Hun*

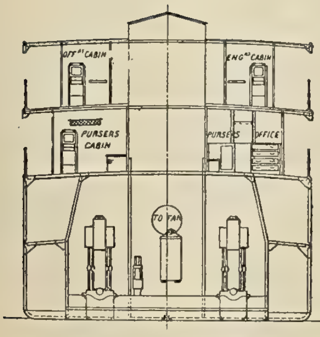


Fig. 3.—Section at 50, Looking Forward

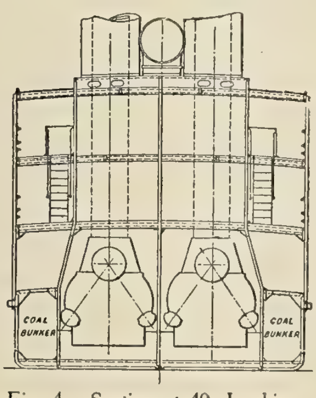


Fig. 4.—Section at 40, Looking Aft

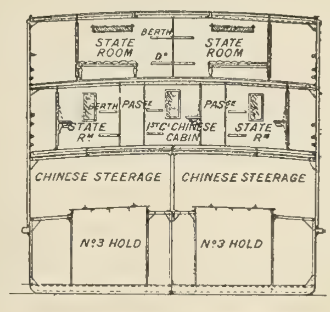


Fig. 5.—Section at 30, Looking Aft

170 Chinese steerage passengers, 15 firemen and three Chinese engineers.

The vessel is lighted throughout with electric light, the current being supplied by an oil-driven dynamo, so that it is not necessary to keep up steam when the vessel is moored for the night. There are five separate holds for cargo, having a total capacity of about 16,000 cubic feet, and on a draft of 5 feet the steamer has a deadweight capacity of about 300 tons.

The main propelling machinery consists of two sets of triple-expansion, surface-condensing engines, balanced on the Yarrow-Schlick-Tweedy system. Piston valves are fitted to the high-pressure, mean-pressure and low-pressure cylinders. The link motion is of the twin-bar Stevenson marine type, with adjustable bearings. All the bearings have large surfaces, so as to insure satisfactory results with these engines when running at somewhat higher revolutions than those usually adopted for this class of vessel. One condenser of the "Uniflux" type is fitted as common to both engines, and an independent Weir air pump is fitted in conjunction with it. A circulating pump by Messrs. Matthew Paul, of Dumbarton, is fitted, the engine being of the enclosed forced lubrication type. A fire and bilge pump by Messrs. Turnbull is also fitted in the engine room and arranged to pump from several compartments and the sea. At the forward end of the engine room is placed a feed filter tank.

In the closed stokeholds are fitted two Yarrow patent double-ended watertube boilers, each boiler being fitted with an independent funnel. These boilers are designed so that, if at any time an overload power is required, it can be quickly obtained by burning oil fuel in conjunction with coal. Other auxiliaries fitted in the stokehold are as follows: Two forced draft fans and engines by Messrs. Paul, of Dumbarton, the engines being of the enclosed, forced lubrication type; two main feed pumps (one to each of the boilers) and one auxiliary feed pump, all by Messrs. Weir; and one oil fuel pump by Messrs. Mumford, of Colchester.

Fig. 2 shows the Yarrow hinged balanced flap for the propeller tunnel. The efficiency of the propellers depends upon their working in solid water, and it is therefore important that when the propeller starts revolving in the tunnel, and the air is forced out and water takes its place, there shall be no leakage back of air. The after part of the tunnel must project below the surface of the water, even when the vessel is at its lightest draft. When the vessel is loaded, and this projection is more deeply immersed, resistance is increased very considerably. Messrs. Yarrow, many years ago, arranged for the after part of this tunnel to be movable, so that it could be adjusted corresponding to the draft of the vessel. The adjustment was effected by hand, and the range was such that, while the tunnel was always sealed, the after part would only just be below the surface of the water. It was found in practice, however, that this adjustment was not always made by the ship's company. Messrs. Yarrow therefore arranged for the flap to be self-balancing, as illustrated. The forward part of the tunnel forms part of the hull in the usual way, but the after part is hinged at a point about the center of the tunnel, and the flap is balanced by means of weights attached to the end of a chain, which passes over pulleys and is secured to the end of the flap, as shown. By this means the flap automatically regulates itself. If, for instance, a quantity of cargo is put on the boat and the draft increased, the increased pressure of water on the after part of the tunnel, due to the action of the more deeply immersed propellers, tends to raise this flap, and thereby reduces its resistance. Under all conditions of load and draft the flap is always in an efficient position.

Motor Fire Float Delta II

Shallow Draft Vessel with Triple Tunnel Screws Driven by Kromhout Kerosene (Paraffin) Motors

Although a fire float is not a craft required in great numbers, the problems involved in its design are closely related to those of other shallow draft vessels, and the *Delta II*, a fire float recently constructed for the London County Council by Messrs. John Samuel White & Co., Ltd., of East Cowes, I. W., is an example of difficulties overcome by careful design. She is of the following dimensions: Length, 100 feet; breadth, extreme, 21 feet 6 inches; depth, 4 feet 1 inch, and draft, loaded, 2 feet. The main power installation consists of three sets of Kromhout kerosene (paraffin) motors, built by Messrs. Plenty & Son, of Newbury, arranged with reversing clutches to drive three screws in separate tunnels aft. Each motor develops 56 brake horsepower, and the three engines, when used together, give the vessel a speed of 10½ knots. Each may be declutched from the tail shaft and direct coupled to a Hatfield fire pump, built by Messrs. Merryweather. The total discharge capacity is about 1,450 gallons per minute, at a pressure of 120 pounds per square inch.

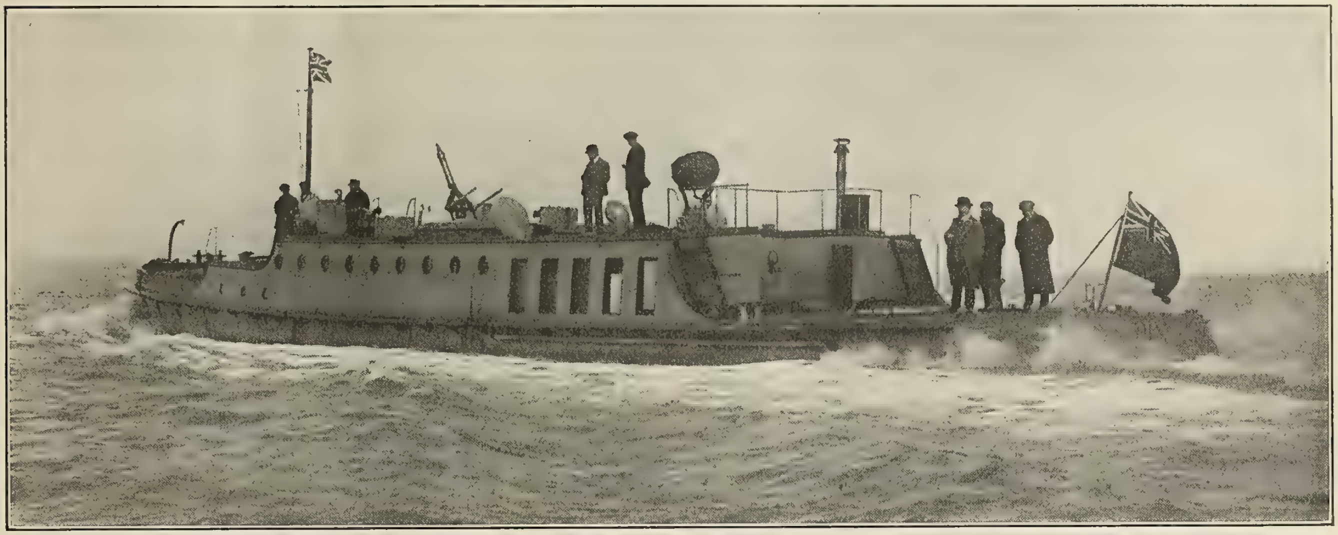
One of the chief features of the installation lies in the possibility of ready and convenient starting. This is accomplished in the following manner: A small air-compressing set, consisting of a 5 horsepower Seal kerosene (paraffin) engine and Brotherhood compressor, is fitted, and this is arranged to charge some ten steel bottles to a pressure of about 150 pounds per square inch. A half compression device is fitted to the main engines, relieving compression on the up-stroke. On the crankshaft are two cams operating timing gear for the starting air valves to each cylinder, and air from the bottles is thus admitted at the proper periods. When a start is to be made, the engines are run on compressed air until firing on gasoline (petrol) commences, after which the change from gasoline (petrol) to kerosene (paraffin) is made when sufficient heat has been generated. There is so large an air supply that a considerable amount of maneuvering can be carried out on air alone, but in addition to this the little compressing plant is capable of keeping the main engines running slowly on air, even should the bottles become exhausted. It will be seen, therefore, that the council have adopted the most certain methods of starting possible.

The main engines, a large part of whose duties consist of driving the water pumps, are liable to special demands on their flexibility. In order to get this quality in a high degree, special means have been adopted. Those of our readers who are familiar with this type of Kromhout motor will remember that ignition is effected by means of an oscillating low-tension magneto. In the present installation the timing, unlike standard practice, is variable, so that a spark can be produced at the plug points during almost any part of the stroke desired.

It is the practice in Kromhout engines always to em-

ploy a reverse gear, and as the result of experiments carried out some fourteen years ago, a type of epicyclic reversing gear was introduced whose design has proved so satisfactory that no alterations in principle have been necessary. The gear is carried in a frame which is bolted directly to the engine crankcase, assuring perfect alinement, and it may be described as fool-proof, since the gears are always in mesh and by no amount of careless handling can they become chipped or damaged.

The clutch comprises a number of steel disks placed alternately with an equal number of disks in which a ring of circular plugs has been inserted. The plugs consist of a composition of sawdust and cement, compressed and hardened, and are renewable. New plugs might be required once in a period of about three years, and the operation of renewal takes some two hours. A special feature of the clutch is the absence of any kind of spring.



Motor Fire Float *Delta II*, Built for the London County Council by Messrs. John Samuel White & Co., Ltd., East Cowes, I. W.

Owing to the slight depth of the hull it is, of course, impossible to arrange any accommodation with standing headroom under deck. A large deck house, therefore, has been erected amidships, which completely covers the engine room, and in addition encloses a roomy cabin divided by a bulkhead from a messroom, lavatory and pantry.

At the forward end the deck erection is dropped slightly, giving a rather reduced headroom to a compartment which is used as a hose room. The drop thus formed gives an excellent standing platform for the control station, which is immediately over the hose room. The main fire pump delivers through pipes to a Shand-Mason monitor on deck, which is placed amidships on the center line, and also to two distributors, each having four hose connections, on the starboard and port sides respectively. Over the cabin aft is a large searchlight.

The three propellers, of 3 feet diameter, run in three independent tunnels. The height of the tunnel above the waterline is a little less than half the propeller diameter.

Three single plate, balanced rudders are fitted aft of the propellers, one in each tunnel, and both propeller and rudder are carried sufficiently high in the tunnels to clear the ground, so that in cases of special necessity which might arise under certain conditions the boat can be beached quite safely. Inspection hatches are fitted over each of the propellers, which are, of course, fitted with a crutch, so that weeds and other *débris* may be cleared from the propellers when necessary.

The naval architects for the vessel are Messrs. Wells & Kemp of 63, Queen Victoria Street, London, E. C.

The Diesel Motor Tug Chickamauga

BY GEORGE E. NICHOLSON

A recent addition to the fleet of the Pacific Tow Boat Company, of Seattle, Wash., is the motor tug *Chickamauga,* which is the first Diesel-engined tug in America and the highest powered internal combustion engined tug on the Pacific. The boat was designed for general towing on Puget Sound and is 70 feet long, 18 feet beam and 10 feet extreme draft. She has a large wheel house raised above the captain's room aft, so that from the rear windows the man at the wheel has an unobstructed view of his tow. This is a most important feature in connection with log towing.

The engine room shows the complete absence of piping and auxiliary equipment, as all of the engine piping is under the engine room floor, and the little auxiliary lighting engine, which is also hooked up to a Nleseco emergency air compressor, is placed out of the way forward. On the starboard side are four fuel tanks, ¼-inch steel, government inspected. She has enough fuel capacity for thirty days' running without refilling.

Fig. 1.—Tug *Chickamauga*, Equipped with Nlseco Diesel Motor

On deck just aft of the galley is the towing machine, which is geared to the propeller shaft; also forward is the anchor winch, so the main engine furnishes all the power requirements of the boat. There is also a pulley on the forward extension of the crankshaft which carries a belt for driving the generator, this arrangement doing

away with the necessity of using the small engine when the main engine is running.

The main propelling engine is a Nlseco Diesel four-cylinder, four-cycle, single-acting type with enclosed crank case, built by the New London Ship & Engine Company of Groton, Conn., and is rated at 240 brake horsepower at 240 revolutions per minute. The bore is 13 inches and the stroke 18 inches. The engine is reversed by means of a heavy duty reverse gear and clutch. The cylinders are each a separate casting.

The valve arrangement is a distinct feature of the Nlseco engine, the inlet and exhaust valves being horizontal, the inlet valve being located on the front side of the cylinder, the exhaust valves on back and both operated by rocker arms actuated by the cams on the cam-shafts, the cam shafts in turn being driven by spur gears from the crankshaft.

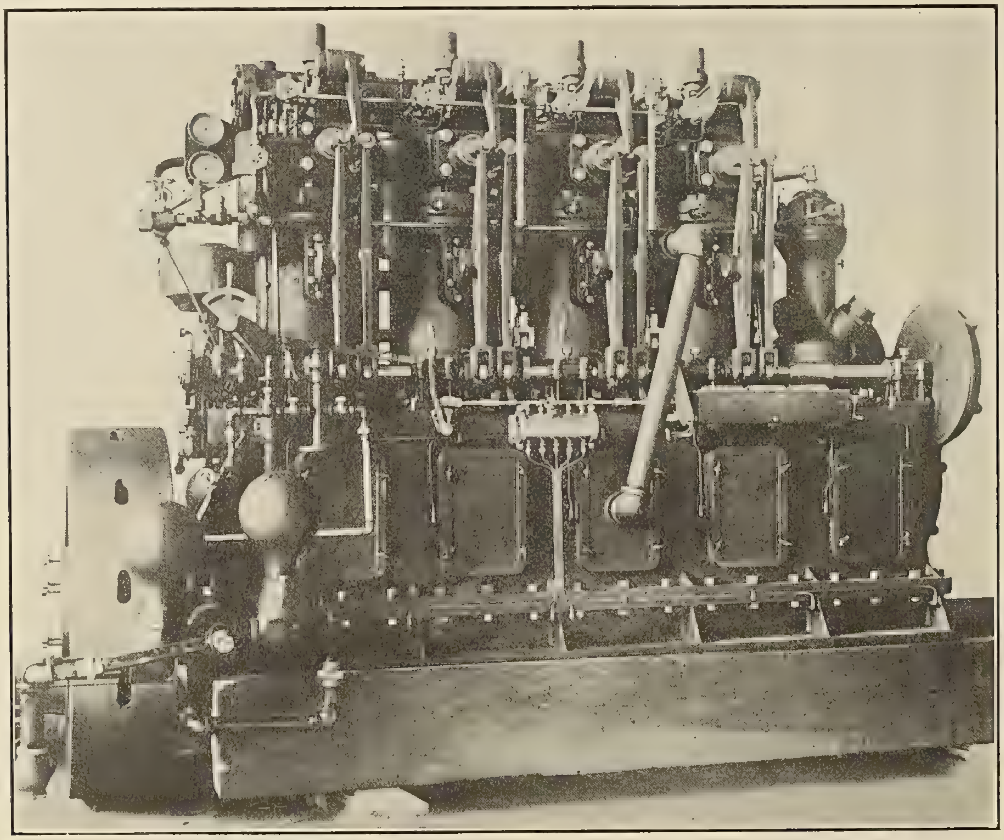


Fig. 2.—240 Horsepower Nlseco Engine for Tug *Chickamauga*

The spray or fuel valves are placed on top of the cylinder heads so that the charge enters the cylinder directly over the center of the piston, and these valves are also operated by rocker arms and bell-cranks which are actuated from the front cam-shaft.

The air-starting valves on the two inside cylinders are actuated by push rods from the front cam-shaft. The fuel oil pump is a noticeable feature and consists of four plungers, one for each cylinder, these being mounted in pairs on two eccentrics driven from the after end of the front cam-shaft. Furnishing a pump for each cylinder makes it possible to get a fineness of adjustment that gives high efficiency and unusual economy. Speed variation of the engine is obtained by the use of a throttle which cuts down the fuel supply to the cylinders, and a governor driven from the after end of the back crankshaft, which prevents racing by cutting off the fuel supply.

The circulating water is supplied by a plunger pump located between the housing and flywheel and driven from the main shaft. This plunger pump is furnished in duplicate, and as only one is needed the extra pump provides a standby for emergency.

There is a single-acting, two-stage air compressor forward which is driven by the main crankshaft. The air obtained from the compressor is used for spraying the fuel into the cylinders and for starting the engine, the air for both purposes being stored in flasks and placed out of the way in the bilges. Air for the original starting and fuel injection is obtained from the emergency compressor driven by the auxiliary engine. After the installation of the main engine and its first running the emergency compressor is rarely needed.

Air for the whistle is drawn from the starting air tank and passed through a reducing valve so that the pressure is lowered to about 125 pounds. This whistle air is stored in a galvanized whistle tank hung on the deck beams.

The engine is started by means of compressed air with starting attachments on two cylinders, so that as soon as started and on almost the first revolution, the remaining two cylinders begin to fire on oil, after which the starting gear is thrown out and starting cylinders then operate on oil.

The lubrication is by a positive circulating oiling system. The oil is supplied from a pump to a duct in the bottom of the bedplate. It then passes up through holes drilled in the bedplate to the main bearings, thence through holes in the crankshaft to the crankpins, and after that through the connecting rods to the wristpins. As the engine crank-pit is all inclosed, the flying oil is confined and drains back to a sump in the bedplate, where it is strained and used over again. A mechanical lubricator shown forward on the front of the engine and driven from the front cam-shaft is provided for oiling the cylinders. It

will thus be seen that the lubrication of the engine is substantially automatic, requiring very little attention from the operator.

At full power the engine burns only 12 gallons per hour of 2¼ cents (0/1⅛) California fuel oil, a cost of 27 cents (1/1½) per hour; lubricating oil, 1/7 gallon, costs 6 cents (0/3) per hour. From this it is seen that the combined fuel and lubricating cost of her 240 horsepower Nlseco Diesel is only 33 cents (1/4½) per hour. During the first month the *Chickamauga* was in commission the consumption of fuel averaged about 6 gallons per hour, which is, as the boat handled average tows, a quite remarkable showing.

One tow made by this boat was 150 miles when she had in tow a log raft made up of two booms of ten sections each. With this tow, both with and against the tide, the *Chickamauga* averaged a speed of two knots. Another tow of about 40 miles was made when she handled a double raft containing about 1,000,000 feet of very large cedar logs over 100 feet long and more than 3 feet thick at the butt, at a rate of two miles per hour and the engine developing full power at 240 revolutions per minute.

Marine Oil Engines for Commercial Work

Wide Application of Mietz & Weiss Oil Engines to Work Boats—Construction and Operation of the Engine

The long period of development and study in the production of an internal combustion engine which would combine the primary requirements of complete reliability with low fuel cost has resulted in the application of the Mietz & Weiss marine oil engine to a large number of working vessels. Because of the weight limitations imposed by shallow draft boats, this engine has found a particularly fertile field in this type of work. Its light weight compared with the power developed, its economy in fuel, resulting in saving in necessary weight of fuel carried, and the total absence of cumbersome and heavy auxiliaries have made it ideal for this purpose.

Fig. 1.—Shallow-Draft Ferryboat *Esperilla*, Propelled by 12-Horsepower Mietz & Weiss Oil Engine

It is quite evident that in any power-propelled vessel a saving in weight and space of propulsive machinery adds correspondingly to the amount of cargo which can be carried. This avoids carrying around a lot of deadweight at a definite cost. At the same time, it adds largely to the earning capacity of the vessel, and frequently would bridge the difference between operation at a loss and operation at a profit.

The engine is built both direct reversing and with reversing gear. The reversible type covers engines of three to six cylinders, in sizes from 45 to 600 horsepower. As fitted with reversing gear, the engines are built from one to four cylinders and from 2 to 80 horsepower. The weights of the different size engines complete run from about 120 to 175 pounds per brake horsepower, depending upon the speed and other characteristics.

The simplicity of operation of the Mietz & Weiss engine will be realized when it is known that the engine is entirely free from such auxiliary devices as electric ignition, carburetors, vaporizers, cams and cam shafts, gears, valves, etc. The absence of carburetors or ignition devices takes away one of the largest causes of trouble in internal combustion engines, for it is estimated that about 90 percent of such troubles are due to these items. As the moving parts are confined to the piston, connecting rod, crank shaft, reversing device and the fuel pump controlled by the governor, it is evident that no successful power engine could possibly get along with less.

This is a two-cycle engine, so-called. The first Mietz & Weiss engine of this type was built in 1895, and is still in active service. As it has already given its owner twenty years of successful and constant service, the question of durability is at once disposed of. All of this is helped by the very small number of moving parts and consequent absence of adjustments. There is less wear, less breakage and fewer shutdowns; less attention and me-

Fig. 2.—Survey Boat *Lafleur*

chanical knowledge required. This means an extremely low cost of maintenance.

Every downward stroke of the piston is a power stroke. The fuel is sprayed directly into the combustion chamber, shortly before the completion of the upward or compression stroke, thus avoiding all leakage of fuel through the crank case or exhaust ports. The amount of oil injected is proportioned to the load by the governor, which is so adjusted that the engine cannot race, even should the propeller or shaft break.

The utility of the reversible engine is self-evident. Both this type and that with reversing gear may be installed for control from the pilot house. On a small boat this makes it possible to operate with one man. In any case, the care of the engine requires only a small part of a man's time, leaving him free for other duties. And, of course, there are no "standby" losses.

The Mietz & Weiss oil engine has been operating for years on low grade oils, using about 0.6 pound for horsepower hour. Kerosene (paraffin), fuel oil, distillate, crude oil or alcohol may be used. As gasoline (petrol) is never used in these engines, one very prolific source of danger is avoided. The lack of exposed gears, cranks and cam shafts means safety for the operator. All parts are designed with an unusually high factor of safety, and with special attention paid to balance in order to prevent vibration.

As the compression pressure is very moderate, this engine avoids the severe stresses, excessive bearing pressures, and lubricating troubles from which engines with high compression suffer. The troubles so common to engines which rely upon the heat of compression to ignite the charge are wholly unknown in the Mietz & Weiss engines. These facts are largely responsible for their record of reliability.

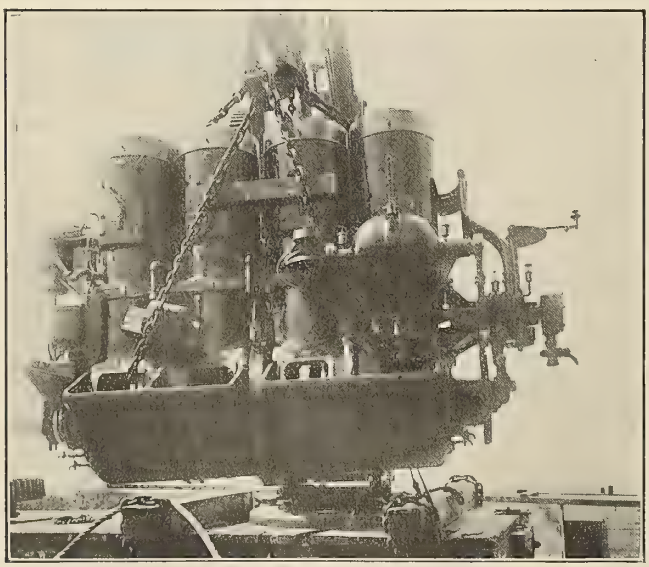


Fig. 3.—100-Horsepower Direct-Reversible Oil Engine Installed in the *Santiago*

Among the shallow draft craft operated by this type of engine, we show a picture of a ferryboat run by Esperilla Hermanos at Cartagena, Colombia. This ferry is operated by a 12 horsepower engine, driving a paddle wheel aft. The illustration shows how the entire equipment is contained within the small deck house with its raised pilot house. Everything is under the control of one man in the pilot house. This craft is fitted for handling passengers, teams, etc.

Another illustration shows the survey boat *Lafleur*, also driven by a Mietz & Weiss oil engine, operating a stern wheel through chain and sprocket. The motive power in this case is a 15 horsepower, two-cylinder engine, located

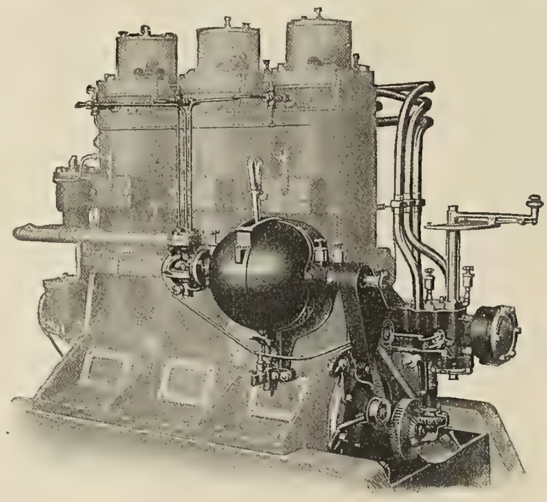


Fig. 4.—The Mietz & Weiss Direct-Reversible Engine, S & W Reversing Valve, M & W Governor and Oil Distributor

just inside the stern of the deckhouse. The vessel is used in the Saskatchewan district of the Canadian Northwest.

The third illustration shows a four-cylinder, 100 horsepower, direct reversible oil engine being installed in the freight and passenger vessel *Santiago*, which runs between Cartagena and Tula, Colombia. This is owned by L. Pocaterra & Co., and operates for a distance of one hundred miles on the Sinn River. The vessel measures 110 feet in length by 23 feet in beam, and when loaded draws 6 feet of water. She is listed at 90 tons. The engine, which weighs 11,050 pounds, has an overall length of 9 feet 5 inches, with a width of 3 feet 7 inches and a height above foundation of 6 feet 4 inches. It runs at 340 revolutions per minute.

The reversing gear of the Mietz & Weiss engine is of extremely simple but rigid construction. When the engine is running ahead the gears are idle and power is transmitted direct to the propeller shaft through a solid coupling. When the gears are thrown in they are locked in proper position, and as they run in oil and are enclosed in an oil-tight casing the friction is reduced to the lowest possible point. The propeller thrust in either direction is taken up by large roller thrust collars.

The S & W distributor fitted to this engine is standard on all the larger marine equipments with three or more cylinders. It makes the control of the engine extremely simple. The lever at the right controls the direction of

operation of the engine, and at the same time positively controls the fuel injections by varying the opening in the inlet valve. In the meantime, the engine speed is controlled by the throttle on the governor, which is shown in the center of the illustration.

The S & W distributor is a rotary valve with a positive drive from the main engine shaft. It controls the flow of air from the pressure tanks to the cylinders, to give proper initial rotation in either direction, at the will of the operator. At the same time, it solves very nicely the control of the oil injections when reversing the engine. These injections are stopped positively as soon as the controlling lever is moved to reverse or stop the engine. This allows compressed air to enter the cylinders and start the engine rotation in the opposite direction. As the oil supply is cut out by this movement, the engine can receive no more oil until it again starts to run in the direction called for by the movement of the lever.

This engine, in a number of varying sizes, has recently been fitted to United States light ships, both on the Coast and on the Great Lakes. The question of extreme reliability becomes here one of the greatest importance. In all, the United States Government Service has 144 Mietz & Weiss engines. The builder is August Mietz, 128 Mott street, New York City.

Light House Tender Fern

To meet the needs of the newly created sixteenth Light House District, the United States Light House Department has had built by the Hall Brothers Marine Railway & Shipbuilding Company, Winslow, Wash., a new light house tender called the *Fern,* which was placed in commission last June and is stationed on the coast of Alaska, with headquarters at Ketchikan. The vessel is small, being but 112 feet overall by 22 feet beam and 10 feet depth of hold. Her displacement is 225 tons on a mean draft of 7 feet. She is framed with white oak and planked and ceiled with Oregon pine and fastened with copper throughout.

Her power plant consists in an Almy watertube boiler having 1,780 square feet of heating surface, built for a working pressure of 200 pounds. Oil is used for fuel, the Dahl oil burning system being installed. Her engines were built by the Hefferman Engine Works of Seattle, Wash., and have cylinders 10 inches, 17½ inches and 28 inches diameter by 18 inches stroke, driving a bronze wheel 8 feet 3 inches diameter, which, at 180 revolutions per minute, gives the vessel a speed of 9 knots.

The vessel is complete in every department and has a derrick boom operated from her foremast capable of lifting three tons for use in handling buoys. A double drum, two-cylinder steam hoist located in the forward hold, operates the derrick boom lifting gear, and is controlled by a bank of levers located on the forecastle deck.

Light House Tender *Fern* for Alaskan Coast

The cost of the vessel complete and ready for sea was $90,000 (£18,500).

Modern Self-Propelled Barge for the Mississippi River

The Inland Navigation Company, of New York, is having built by the Howard Shipyards Company, Jeffersonville, Ind., a self-propelled steel barge 240 feet long and 43 feet extreme beam, with a carrying capacity of 1,600 tons of freight on a maximum draft of 7 feet. This barge is the first of a fleet which the owners plan to place in regular service on the Mississippi River between New Orleans and St. Louis.

The barge is all steel, with the hold divided into five compartments by means of four watertight bulkheads. Propulsion is by four four-cycle, three-cylinder oil engines, built by Fairbanks, Morse & Co., each operating one propeller. At a draft of 3½ feet the barge can carry 500 tons, and at its maximum draft of 7 feet it can carry 1,600 tons.

As can be seen from the illustrations, the barge is covered with a steel waterproof cargo box and equipped with an electric traveling crane which, with a boom extended outward on either side for 70 feet, is capable of lifting one ton. The barge is further equipped with a duplicate electric power plant for heating, cooking and lighting. The bow and stern each are provided with 4 horsepower electric winches, the steering is done by electricity and the pilot house is completely equipped with all modern conveniences, such as a mechanical telegraph, telephones, and in addi-

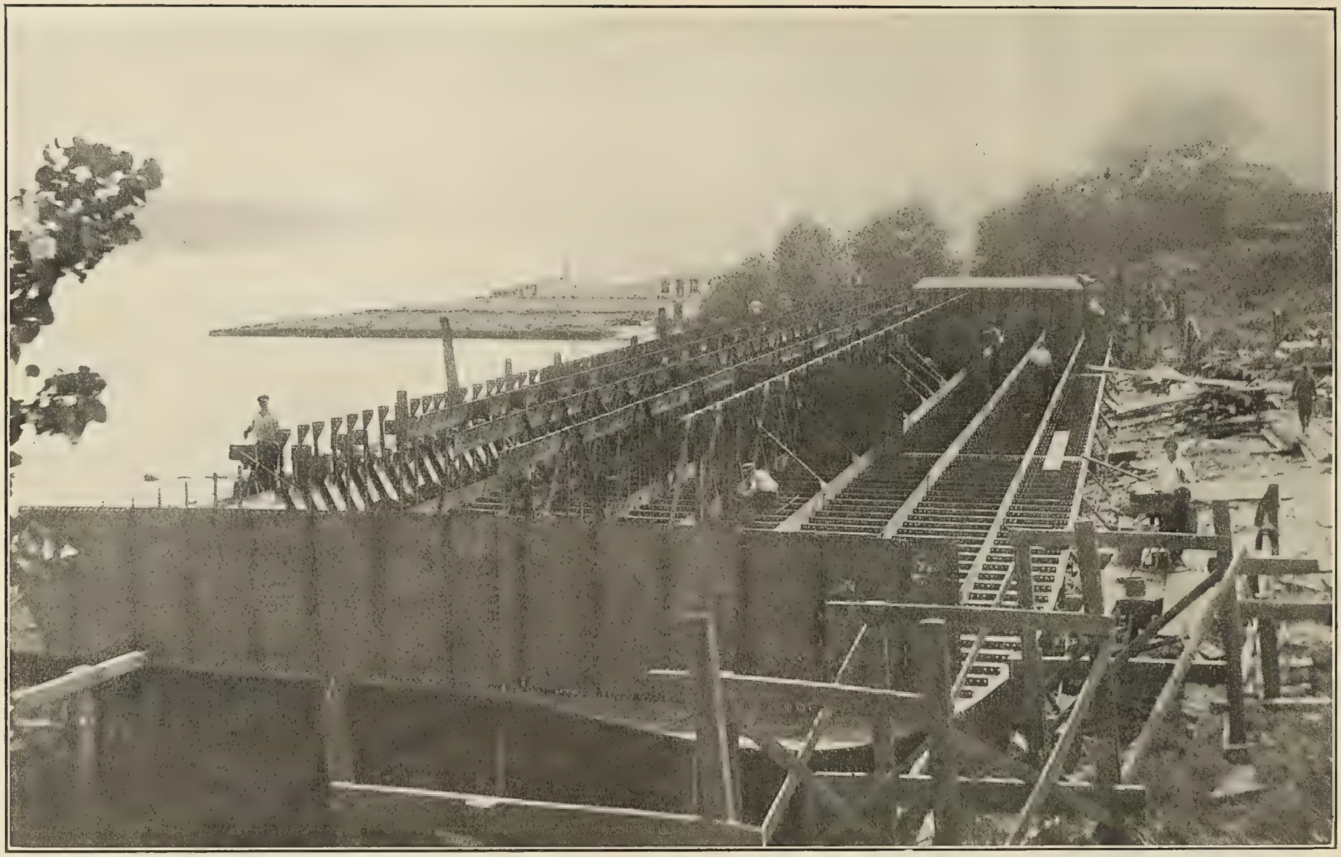


Fig. 1.—New Barge for Inland Navigation Company, Under Construction at the Howard Shipyards, Jeffersonville, Ind. The Barge is 240 Feet Long and 43 Feet Extreme Beam, with a Carrying Capacity of 1,600 Tons of Freight on a Draft of 7 Feet

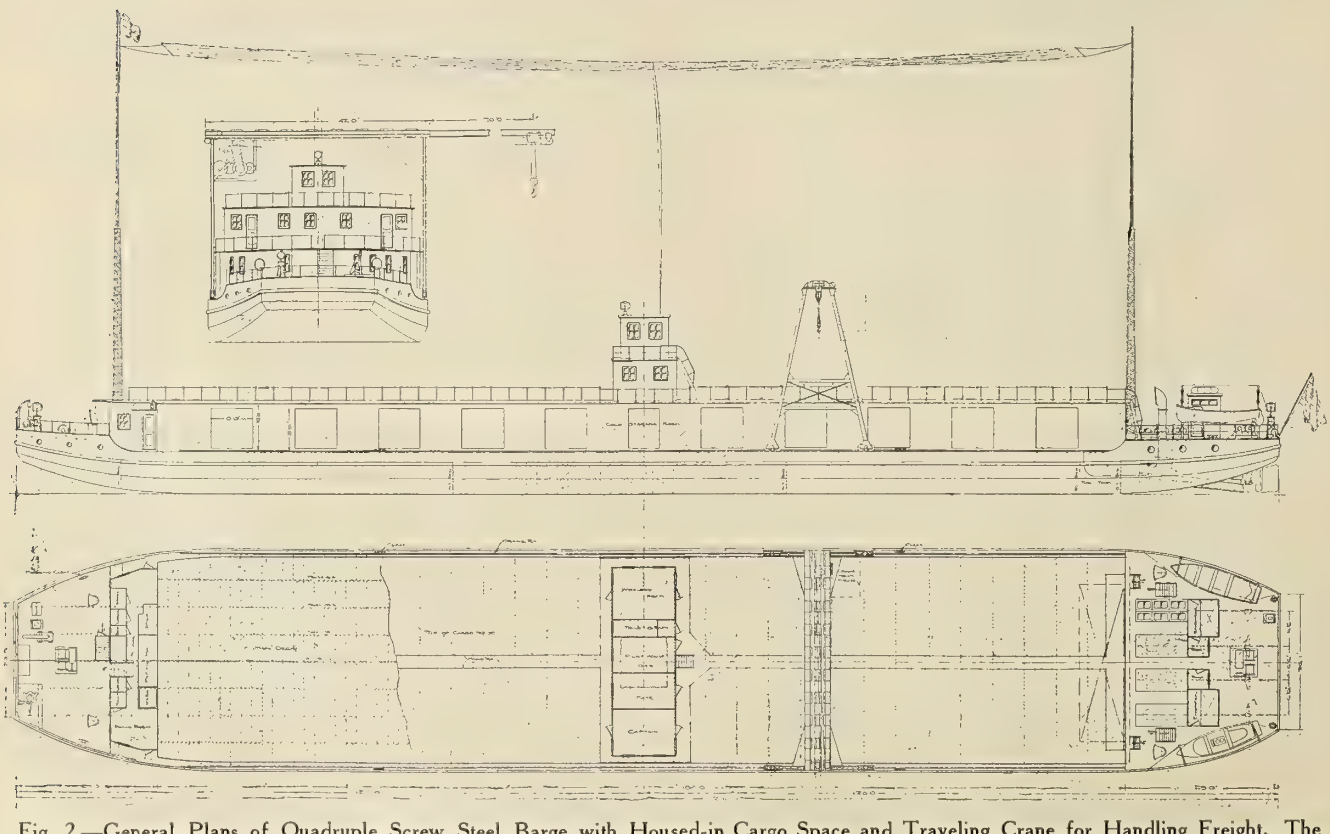
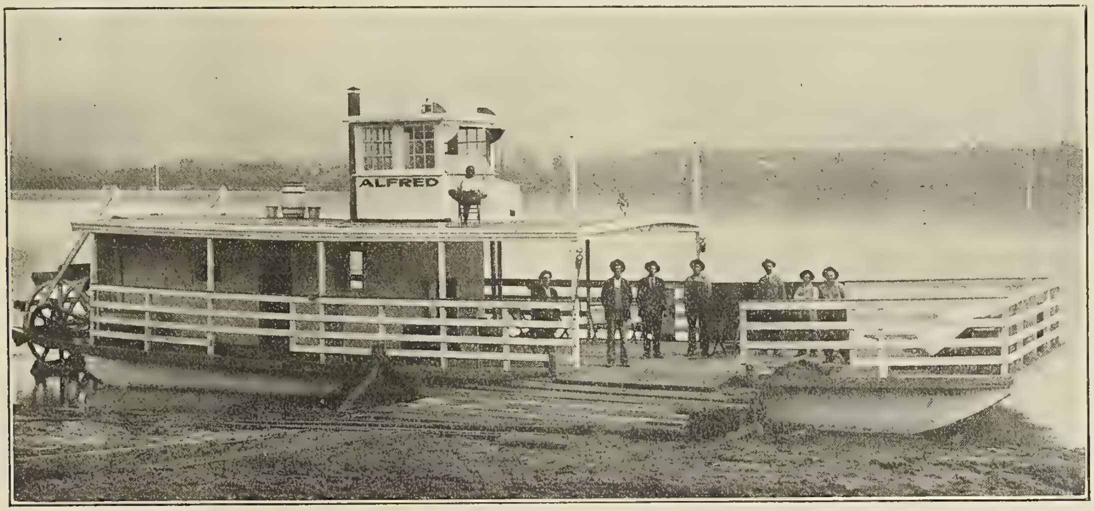


Fig. 2.—General Plans of Quadruple Screw Steel Barge with Housed-in Cargo Space and Traveling Crane for Handling Freight. The Barge Is Propelled by Four 80-Horsepower Oil Engines, and Is Equipped with Electric Plant and Wireless Outfit

tion a wireless outfit. Two 5-inch centrifugal pumps, electrically operated, are connected to the bilges and ballast tanks. Two refrigerating plants are to be installed, one for the crew and one for the cargo, capable of maintaining a temperature of 35 degrees for a cargo of 6,000 cubic feet.

Stern Wheel Motor Ferry Boat on the Ohio River

An unusual type of ferryboat is operated on the Ohio River at Metropolis, Ill. The boat is named the *Alfred* and was built by its owner, Mr. Thomas E. Cutting, of Metropolis. It is 60 feet long and 20 feet beam, with a depth of hull of 3 feet. Power for operating the boat is derived from a 28-horsepower, four-cylinder Clifton gasoline (petrol) marine engine, which through bevel gears, a cross shaft and sprocket wheels drives a paddle wheel at the stern 8 feet diameter and 11 feet long, fitted with ten buckets. Reversing is accomplished through a marine engine reverse gear at the engine. The engine was built by the Clifton Motor Works, Cincinnati, Ohio, which is the gas engine department of the Carlisle & Finch Company.



Stern Wheel Motor Ferry *Alfred*

Light Draft Tunnel Boat

The river boat *Margery* 3, illustrated herewith, is of tunnel stern construction 55 feet long, 12 feet beam and 30 inches depth, built by the Rippley Mfg. & Steel Boat Company, Grafton, Ill. The hull is of 10-gage galvanized steel plates with frames of 3-inch channels spaced 15 inches apart. Propulsion is by two 20-horsepower and one 50-horsepower gasoline (petrol) engines, the draft of the boat being 22 inches.

Shallow Draft Tunnel Boat *Margery 3*

Foundering of Steamer Edith

The steamer *Edith,* carrying a cargo of copper concentrates from Latouche, Alaska, to Seattle, Wash., was abandoned on August 30 in the Gulf of Alaska without loss of life. Copper concentrates are shipped in the form of mud and in heavy weather this is an extremely dangerous cargo. When this cargo shifts, throwing a ship on her beam ends, it is impossible to either trim cargo or right the vessel. The *Edith,* carrying 2,800 tons, encountered very tempestuous weather, and when her cargo shifted the steamer was left in a very precarious predicament.

Efforts to right the vessel were futile, and as the stormy weather continued it was determined to abandon her. It was too rough to board the lifeboat alongside, so the small boat was rowed some distance away and officers and crew were compelled to leap from the *Edith* and swim for the lifeboat. A few hours later the survivors were picked up by the passenger steamship *Mariposa.*

Attempts to tow the *Edith* to shelter failed and the vessel was left to her fate. She was photographed just at sunset as she was ready to plunge to the bottom of the Gulf of Alaska.

The *Edith* was one of the largest freighters operating out of Seattle to Alaska. She was built at Sunderland, England, in 1882, and has been on the Pacific coast for nearly twenty years, most of this time operating between Seattle and Bering sea ports.

"Her Last Sunset"

The ship was valued at $200,000 (£41,000) and the cargo at about $275,000 (£56,500).

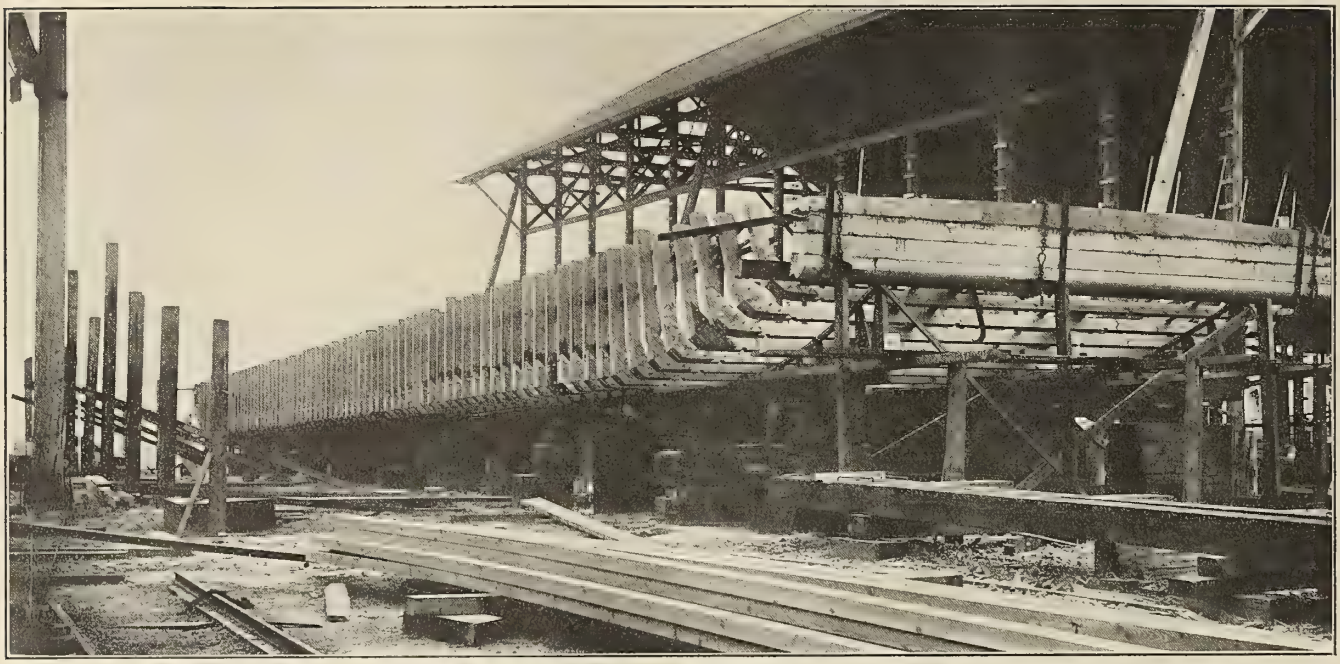


Fig. 1.—Hull of Government Shallow-Draft Snag Boat *Swinomish*, Under Construction at the Yards of the Hall Brothers Marine Railway and Shipbuilding Company, Winslow, Wash.

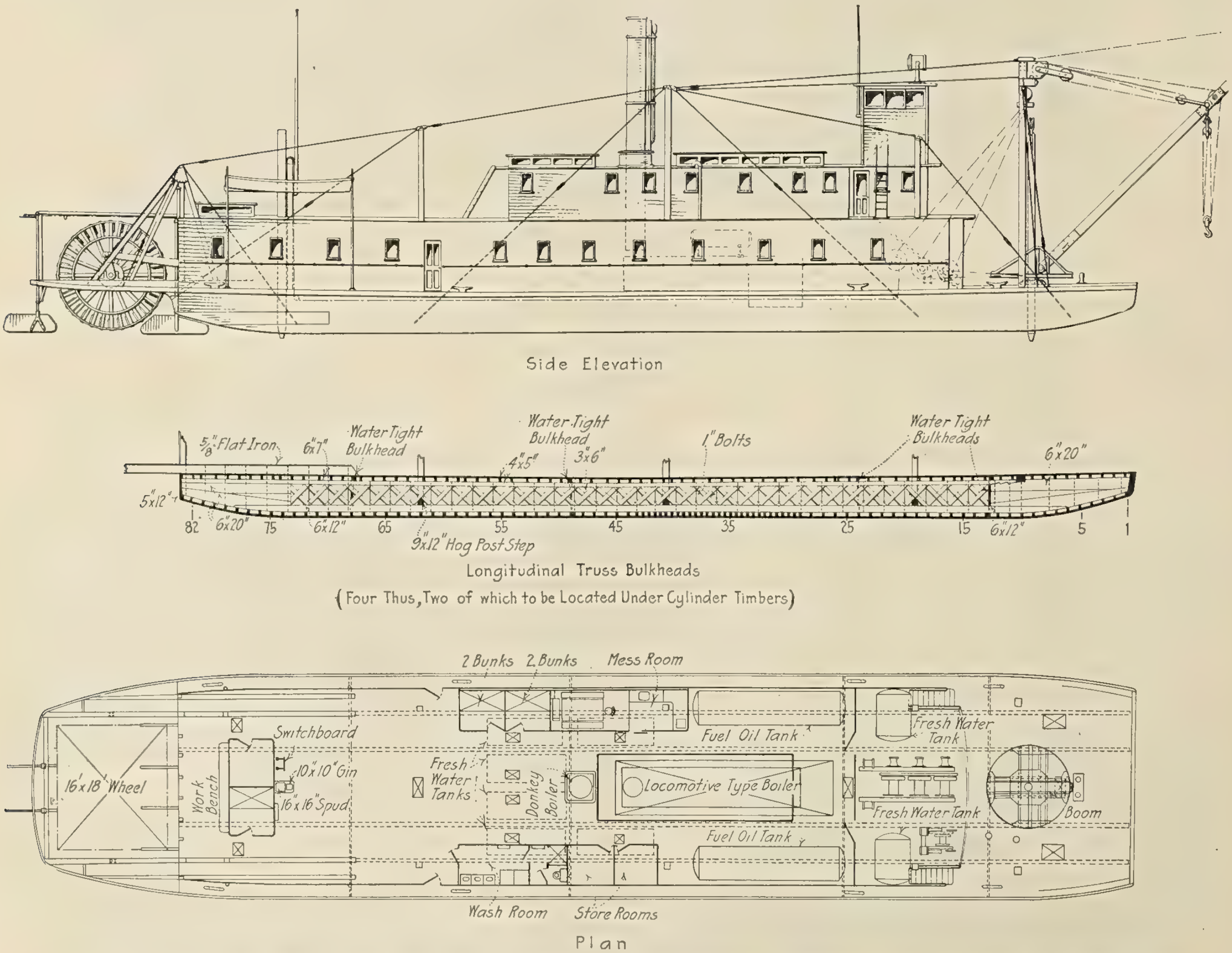


Fig. 2.—Profile and Deck Plan of the *Swinomish* and Section of Longitudinal Truss Bulkhead, Four of Which Are Fitted, Two Under the Cylinder Timbers

Shallow Draft Snag Boat Swinomish

Government Boat Built at Winslow, Wash., for Use on the Rivers and Harbors of the Puget Sound District

The Hall Bros. Marine Railway & Shipbuilding Company, Winslow, Wash., has built for the Engineers' Department of the U. S. Army, Department of Puget Sound, the shallow draft, stern wheel, snag boat *Swinomish,* for use on the rivers and harbors of the Puget Sound district to remove snags and other obstructions to navigation. The boat is equipped with heavy snagging gear operated from an A frame and derrick boom capable of lifting 75 tons, mounted on the forward part of the boat. She is also equipped with clam-shell dredging bucket of 2 yards capacity which is used for dredging purposes on the shallow river bars, etc., in keeping the channels open.

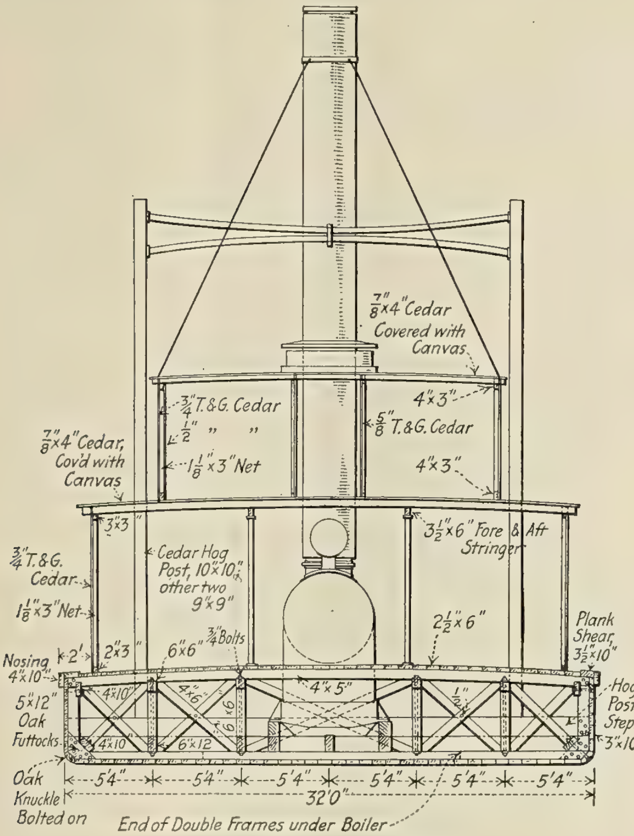


Fig. 3.—Midship Section

The hull is of the barge type with rounded rakes fore and aft, extending about 20 feet from the ends, and has the deck slightly narrower at the ends. The hull is strengthened fore and aft by four longitudinal truss bulkheads of bridge type construction of X braces without posts. Cast iron bridge sockets placed on the keelsons and under deck stringers receive the ends of the braces and a vertical tie rod extending through the sockets, keelson and deck stringer, constitutes the plan of the bulkhead. This is rather a departure from the usual type of truss bulkhead as used in vessels of this type. There are three athwartship watertight bulkheads.

The house is built of light framing and sheathed with cedar in order to minimize the weight of upper structure. There are accommodations for 16 men, those for the crew being on main deck and those for the officers on the upper or cabin deck.

The scantlings of hull are as follows: Floor timbers, 4 inches by 7 inches, spaced 20 inches and doubled beneath the boiler; side frames, 4 inches by 8 inches; deck beams, 4 inches by 5 inches; beam clamps, 4 inches by 10 inches; bilge stringers, 4 inches by 10 inches; bottom planking, 3 inches by 10 inches; side planking, 3 inches by 10 inches; deck planking, 2½ inches by 6 inches. Triangular oak blocks are fitted at the knuckle of the frames connecting the side to the floor frames.

The engines were manufactured by Gillette & Eaton, of Detroit, Mich., and are 14 inches diameter by 72 inches stroke, designed for a working pressure of 200 pounds. The boiler is of the locomotive firebox type. Oil is used for fuel and ample storage tanks are located on the main deck at sides of boiler. The Dahl oil burning system is used.

Fig. 4.—End View, Showing A-Frame and Derrick Boom

The electric light plant consists of a General Electric Company's generator direct connected to a vertical engine. The generator is a 7 kilowatt, 110 volt machine and is connected for supplying lights direct from the generator when steam is up, and is also connected to two sets of Edison storage batteries from which light is supplied when steam is down. A 1,600 candlepower searchlight is mounted on top of the pilot house.

As the vessel has to navigate many rapid, tortuous streams where rapid handling of her rudder becomes necessary, a specially designed combined steam and hydraulic steering engine, designed and built by the Washington Iron Works of Seattle, Wash., has been provided. This consists of one steam cylinder and one water cylinder mounted on one frame, with the two cylinders facing each other at its ends. One piston rod connects to the pistons in both cylinders and has a double shive housed

in the center of same sliding on cross head guides. The tiller ropes connecting to the rudders and to the steering wheel in the pilot house pass around these shives, one from each side of the ship in their lead from the rudders to the pilot house. When it is desired to use the steering engine the steering wheel in the pilot house is locked secure in a midship position and power is applied to the steering engine, which rapidly throws the rudders through the action of the pistons and shives on the bight of the tiller ropes. When it is desired to use the hand-steering gear in the pilot house, the operation is reversed in locking the pistons in a central position when the shives serve simply as idlers on the tiller ropes, as they are operated by the hand-steering wheel. The vessel is equipped with four main rudders located at the stern forward of the wheel, and two monkey rudders located abaft the wheel, all connected by tillers to the one quadrant.

The vessel was built under the direction of Major J. B. Cavanaugh, Chief of Engineers for the U. S. Army in this district, and cost complete about $55,000 (£11,300). On an endurance run of eight hours at the time of the vessel's acceptance by the department, she made an average speed of 9 knots and handled admirably in every appointment. This type of hull is cheaply constructed and would be well adapted for freight purposes where a shallow draft vessel is required. Her draft when launched was 13 inches, and with all equipment aboard and fuel and water tanks full, her draft is 2 feet 11 inches.

Modern Submarines in War and Peace—V

Construction and Installation of Storage Batteries—Tactics of the Submarine in Warfare—The Invisible Weapon

BY SIMON LAKE *

It is impossible in an article of this character to go into much detail regarding the development of the storage battery. There have been two types in general use. They are both lead batteries, one known as the Plante type, in which metallic lead is used to form both the positive and negative plates. The other type employs what is commonly known as pasted plates, in which various compositions of materials are worked up into a paste and forced into metallic grids to form the positive and negative plates. The pasted type has greater capacity per pound of material used, but much shorter life.

In both of these batteries sulphuric acid solutions are used as the "excitant" between the elements. In charging, hydrogen gas is given off in the form of bubbles, the skin of the bubbles being composed of sulphuric acid solution. These bubbles, when taken in one's lungs, are very irritating, and if they collect in any quantity, or break up and allow the hydrogen gas to mix with the air, there is always danger of creating an explosive mixture within the hull of the vessel or in the battery tanks, which a spark would set off at any time.

Installation of Storage Batteries

The best method of installing batteries on a submarine boat is to have them isolated from the living quarters of the vessel in separate watertight compartments. The elements of the battery should be contained in non-metallic containers and sealed to prevent spilling of the electrolyte under excessive rolling or pitching of the vessel. Means should be provided to discharge the hydrogen gases from the boat as rapidly as formed. Special care should be taken to prevent leakages between the adjacent cells. Circulation of air to keep the cells dry is the best means of preventing this.

Mr. Edison has been working for a number of years on a storage battery suitable for submarine work, and it has recently been stated that he has finally solved the problem of producing a battery that will stand up longer than the lead type of battery, and that it has the further advantage in that it will not give off chlorine gas in case salt water should get into the cells. It should, however, be contained in a separate compartment, which should be ventilated during the charging period, as I understand the Edison battery gives off hydrogen gas the same as the lead batteries. Chlorine gas, as given off from the lead battery when salt water has got into it, has undoubtedly caused the loss of some lives.

Mr. Edison claims that his battery will not give off poisonous gases of any kind when immersed.

Tactics of the Submarine

The submarine boat is the guerrilla in warfare. Its tactics, therefore, are the tactics of the Indian who fights under cover, or lies in ambush for his enemy. This is necessarily the tactics of all weaker individuals, and is an essential method of procedure to prevent the weaker party from being annihilated by the strong and more powerful.

Some people have contended that the submarine is an unfair weapon, but the old statement that "All is fair in love and war" applies to the submarine as it does to every weapon that has been invented since the days when men struggled for supremacy with their bare hands. The first man who wielded the club might have been accused of being unfair; the same with the man who invented the sling shot, or the bow and arrow. When people fight for their existence, the existence of their families or their country, they do not fight according to the "Marquis of Queensberry Rules." A revolver in the hands of a weak man or a defenseless woman is a proper weapon to enable them to protect their property, their honor, or their life; and no matter what theorists may claim, the submarine will remain as a weapon to be reckoned with in all future wars, provided there are future wars upon the high seas, which I much doubt, as I believe the great lesson that is being rapidly taught by this war is that no country can longer claim to be the "Mistress of the Sea," and that when two countries cannot agree they must consent to give up all commerce with other nations until they can agree.

The lesson to be taught by the submarine cannot be learned in a one-year course. It will, in fact, require several years to teach the militarists—that is, the naval

* Member of Institution of Naval Architects (England), Schiffbautechnische Gesellshaft (Germany), Society of Naval Architects and Marine Engineers (United States) and American Society of Mechanical Engineers.

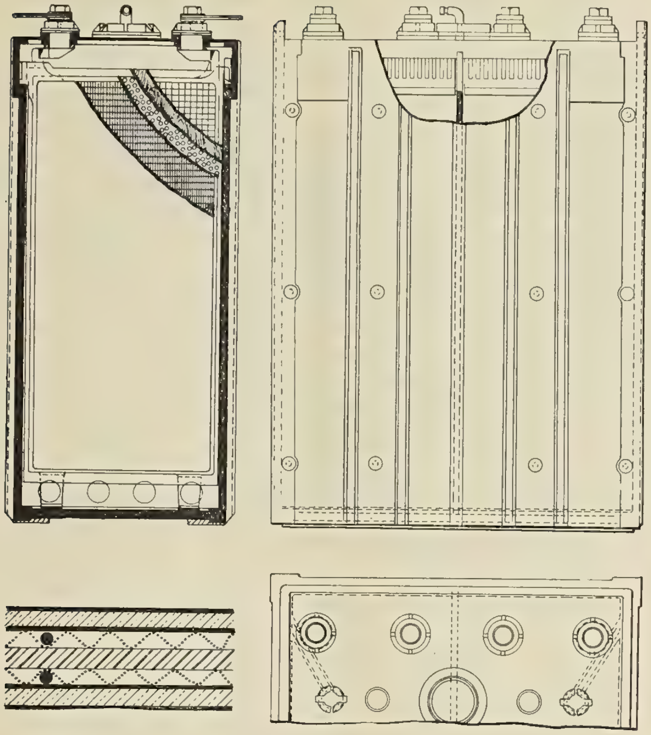


Fig. 42.—Storage Battery Cell

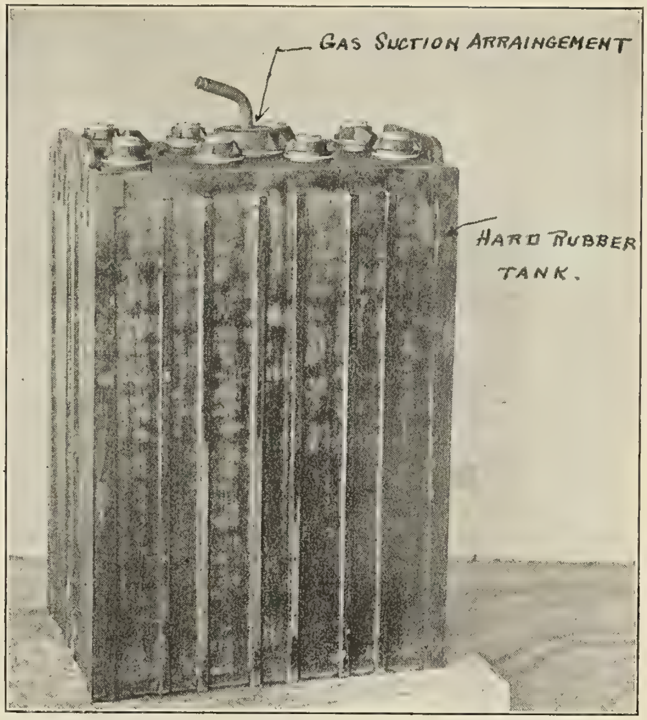


Fig. 44.—A Submarine Cell Completely Assembled Ready for Installation

Storage batteries as used in modern submarines have been especially developed to meet the special needs of submarine-boat service. The requirements for this service are much more severe than those for any other service to which the storage battery has been applied. The batteries as first introduced in submarines were entirely too frail to stand up to their work, and the gases given off from them while being charged were the cause of much distress and danger to the crew, and have been in some cases responsible for the loss of both vessel and crew.

The above views illustrate a modern storage battery cell as developed by one of the largest of the German battery manufacturers; it was built under instructions from the author to overcome certain objections referred to in the text. The cell is composed of a hard rubber outer casing with a sealed cover, a large view of which is shown in Fig. 43.

The cells give off gas only during the charging process. Before charging is begun exhaust fans are started which draw the air down through plugs distributed over the top of the cells. This dilutes the gases as rapidly as formed, and the gas is drawn out through a central filter box, as indicated by the arrows in Fig. 43. This filter box is arranged in such a manner as to break up the bubbles so that only the air and gas is drawn out, the electrolyte returning into the cell. The gas then enters the main duct, passes through the exhaust fan and is discharged overboard. This keeps the battery compartment free of gas and dampness, which was common in previous installations, due to the breaking up of the electrolyte bubbles.

Formerly the plates were assembled and burned to the bus bar within the boat. Now the practice is to assemble the cells complete and with special cell lifting clamps they may be readily installed. The author has had cells of this type built in Southern Germany charged with electrolyte and shipped to Petrograd and installed there in boats complete.

militarists—that there is no escape from this invisible Nemesis on the high seas. It is impossible to fight with the invisible. It is this invisibility which differentiates the submarine from all other weapons of offense or defense that have ever been invented. Mr. Holland, years ago, called attention to the fact that submarines cannot fight submarines. The present war has proved this to be a fact. The North Sea and the English Channel have been infested with submarines of the German, English and French fleets, yet in no case, as far as I am aware, has one submarine succeeded in destroying another. It is probably true, as was reported, that an Austrian submarine sank an Italian submarine, but according to the reports of this encounter the Italian submarine was in surface cruising condition. She was, therefore, not at that time a submarine vessel, and of course was visible to the commander the same as any other surface vessel is visible to the submarine when within range of vision of its periscope.

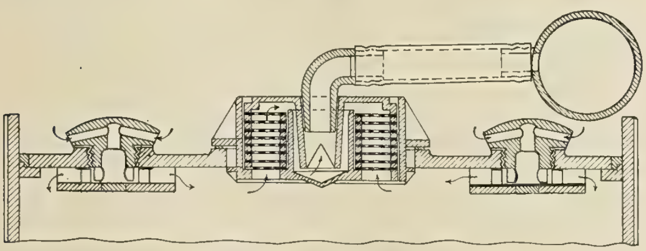


Fig. 43.—Enlarged View of Cell Cover

The difficulty of locating an object like a large vessel when sunk beneath the surface of the sea is so great that in some cases years have been spent in trying to locate them, even in comparatively shallow water, and even though they were known to have been sunk within a short radius of a given point. The writer has spent some years in the study of this problem in connection with the wrecking business. A few illustrations on this point may make clear to the student of this problem what a fallacy it is to contend that a submarine might be detected by a surface vessel or an aeroplane except in shallow waters, and in such localities where the water is very clear.

One case in point is that of the *Rio de Janeiro*, sunk in San Francisco Bay in 1900. This vessel contained, it is reported, a valuable cargo of about $500,000 (£102,500) in gold. Although search was made for her, covering a period of many months, she was never located. I remember another case, that of the steamer *Cayuga*. This vessel was sunk in collision with another vessel within a short distance of a lighthouse. The lighthouse keeper saw her when she went down. The steamer with which she was in collision anchored immediately and took ranges as to her location. Although the depth of water was only 120 feet and the *Cayuga's* masts extended 117 feet from her keel, nevertheless an experienced wrecker with his crew of searchers worked two months before they succeeded in locating her.

Another case on which I, personally, spent considerable time was that of a vessel, loaded with copper ore and copper matte, sunk in Long Island Sound. This vessel was seen to disappear one afternoon between Falkners

Island light and Guilford, Conn. The lighthouse keeper took a range as to where he saw her disappear, and carpenters working on the roof of a house on the mainland at Guilford also took a range as to where they saw her disappear. As she had a valuable cargo, one of the largest wrecking companies in the United States was engaged by the insurance companies to locate her. They spent several months in the endeavor. The bottom where she sank was rocky, which made search by the old-fashioned sweep-line method very slow and uncertain. They abandoned the search and another wrecking company, on its own responsibility, undertook to locate her, since "findings is keepings" after a vessel has once been abandoned. They also failed, and then an old, retired wreck-master took up the job and spent two years in the endeavor to locate her. Even he did not succeed. About this time I brought the *Argonaut* up into Long Island Sound, and hearing of this rich prize, made the attempt myself to locate her and failed with the methods then in vogue. I also found that in our Northern waters it was impossible to see any considerable distance from a submarine boat, even with powerful searchlights. This brought about the invention of special wreck-finding boats with appliances for locating sunken vessels, which increased the speed of searching for under-water objects to a very great extent.

We finally succeeded in locating the copper wreck in 94 feet of water, but that was a case in which no attempt was made to prevent the vessel being located. A submarine fitted with guard arms to prevent a line catching on any projection thereof, so as to permit it to creep into an enemy's harbor, or to lie in wait off the entrance to a harbor, cannot be located even with the means which I finally found successful in locating an ordinary sunken ship. I do not know, nor do I believe, that there is any device that can be found which will locate a sunken object like a submarine especially fitted to prevent her detection in any of our Northern waters where the water is at all turbid.

The idea that a submarine boat may be located by an aeroplane is a fallacy, except in water of crystal-like clearness. In the clear waters of the Mediterranean or the Caribbean Sea it might be possible to locate a submarine in this manner, but the aeroplane's chance to destroy her would be very slight indeed, as the aeroplane must come directly overhead to locate or to drop a bomb on the submarine. Periscopes are now being built so that the heavens, as well as the horizon, may be scanned. The head of a periscope is an object only 4 inches to 5 inches in diameter, and when painted a neutral tint it cannot be seen with the naked eye (when at rest) a distance of over 500 yards. If the sea is a little choppy it is difficult to discover it at a distance considerably less than 500 yards. Nevertheless, the commander beneath the sea, with his telescopic sights, has a range of vision of several miles. A submarine lying at rest, therefore, off the entrance of a harbor, could readily detect an approaching aeroplane before it would succeed in getting a position where the outline of the submarine could be seen, even in clear water, as one must be almost directly overhead to see through the water, since the surface of the water acts as a mirror and deflects the line of vision.

Should an aeroplane be sighted, there would be two courses open to the commander—one to submerge deeper, and the other to come to the surface and with his rapid fire guns attack the aeroplane. In a battle between the comparatively heavy guns carried by the submarine and the light gun carried by the aeroplane, there could be only one result, as the gunner on the submarine would be firing from a stable platform, while the man in the aeroplane would be firing from a rapidly moving, unstable platform, and the chance of getting sufficiently near to drop a bomb on the submarine would not be one in a thousand.

Experiments in dropping imitation bombs on outlines of battleships drawn on the ground have proved how difficult it is for an aeroplane to drop a bomb on a vessel covering as large an area. The maneuvers have been tried in peace times with no one shooting at the aeroplane, yet the chance of their making a hit from a height within the range of an ordinary rifle has been proved to be very slight; thus the aeroplane is not a menace to the submarine.

It is reported that the English have captured a number of the German submarines in nets off the entrances of harbors in different localities in the English Channel. It is reported that these nets are carried by floats which lie practically level with the surface of the water, and cannot be seen from the periscope of the submarine. Some of the newspaper reports would lead one to suppose that submarines were being caught in these nets like herring. One statement which attracted my attention was that a double line of these nets extended from the English to the French coast, all the way across the Channel. These lines were patroled by high-speed surface boats or destroyers with rapid fire guns, grapnels, etc., so that when a submarine ran its nose into the meshes of the net and became "gilled," so to speak, the destroyer would rush to the spot where they saw the float of the nets disappear, and either grapple the submarine and bring her to the surface or lower bombs down on her and destroy her.

It may be true that a device of this nature might have been used successfully where the submarine was not fitted to prevent her being caught in the meshes of a large net; but it would be possible to provide the submarine with devices for cutting the submarine free of the netting or guards which would prevent entanglement in them, so that if nets are to be strung all around the coast line of the country to prevent submarines entering through such lines, we may expect to see devices provided to destroy the nets. A submarine fitted with bottom wheels and guards can under-run a net without difficulty. A guard could also be provided that would readily overrun such a net. Anticipating that such devices might be used in the effort to thwart the object of the submarine, I have designed a type of vessel which I call a "mine-evading" submarine, which I believe can pass through any obstruction except, perhaps, a stone breakwater.

In 1901 I submitted to the United States Government three distinct types of submarines. The first was a small type of vessel designed to be carried on the davits of a battleship or cruiser; the second was what I called a harbor and coast defense type, and the third was what I called a cruiser type, and was designed for offensive as well as defensive warfare.

In 1905 I prepared plans for a mine-laying submarine for submission to the Russian Government, a general description of which was published in 1906. This submarine was designed to carry thirty-six of the regulation naval mines, which could readily be placed in a desired locality while the submarine was entirely submerged. A vessel of this type might be useful for either offensive or defensive purposes. Where used for offensive purposes the mine-laying submarine could readily, with comparatively little danger to herself, plant mines off entrances to the enemy's harbor. Equipped with the "mine-evading" guards, they might even work their way into an enemy's harbor and plant mines under a vessel at anchor, or destroy shipping lying tied up at the docks. For defensive purposes, a mine-laying submarine would be of great value, as it could readily plant mines, even under

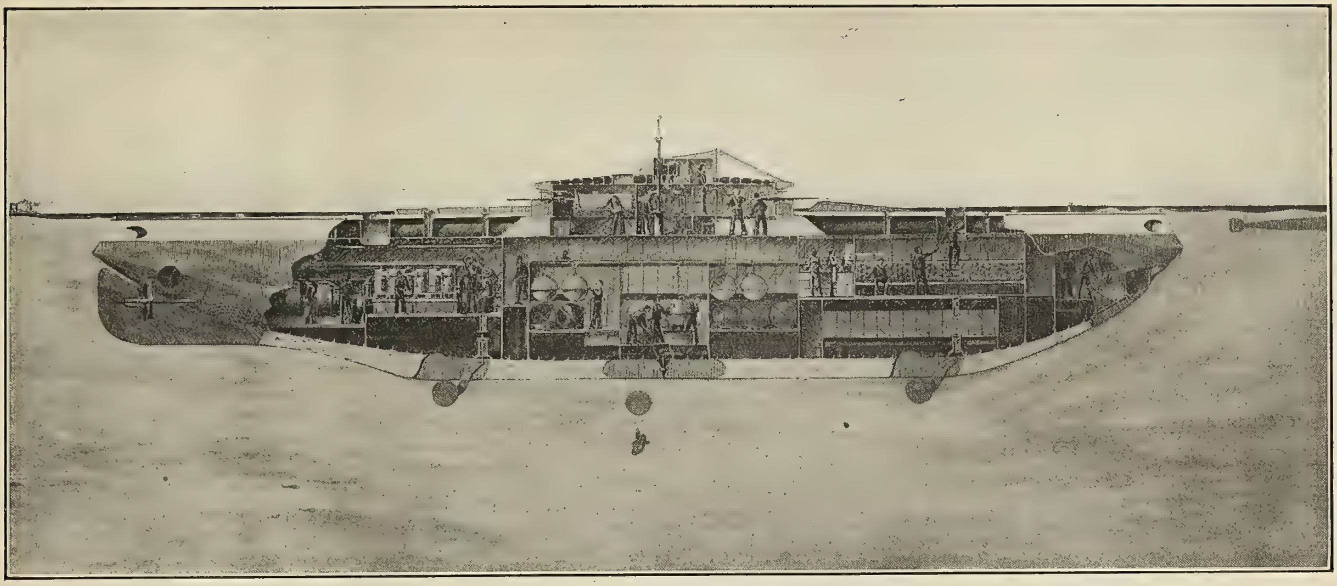


Fig. 45.—Mine-Planting Submarine Designed by the Author in 1895 in Berlin, Germany, for the Russian Government

This vessel, from an outward appearance, resembles the Lake type cruising submarine, fitted with buoyant superstructure and hydroplane control for regulating the depth of submergence when running between the surface and the water bed. It was also provided with bottom wheels to enable the vessel to be navigated over the water bed. It was to have been fitted with four torpedo tubes for discharging Whitehead torpedoes, both fore and aft. She had a diving compartment in the bow, with lookout windows and a diver's door to enable a diver to be sent out ahead of the vessel for the purpose of inspecting the bottom in clearing the way, or to avoid obstructions. The vessel was to have been fitted with two rapid-fire, 3-inch rifles, arranged to fire both fore and aft for warding off the attack of small surface craft. The novel feature of this vessel, however, was the large central compartment, which was designed of sufficient size to carry thirty-six regulation navy type mines; these mines could be planted when the vessel was running on the surface or awash, or when entirely submerged on the water bed.

The above illustration shows the method of planting these mines when running in the awash condition. The mines are arranged so that they can be readily lifted and carried on a trolley over a tube extending outwardly and downwardly from each side of the central operating department. These tubes are fitted with a bottom hatch, which corresponds to the bottom door in the diving compartment. When ready to plant the mines, the central compartment is filled with compressed air, equalizing the pressure of water at the bottom of the launching tube. The bottom hatch may then be opened, and no water will come into the boat, as the trapped air will prevent it from rising up the tube. The mines are then dropped out through the tube. Salammoniac, or some other compound, is used to prevent the mine adjusting depth and firing mechanism from operating until the salammoniac becomes dissolved. This may be set to take place within a few minutes or some considerable time after the mine is placed. The safest way for planting mines from a submarine is to go down on the bottom itself so that the bottom wheels will hold the vessel to her course.

By keeping a record of the revolutions made by the bottom wheels, the exact distance from the starting point can always be determined, and any desired direction can be run by compass. It is thus possible to chart the location of each mine planted, and also to plant each mine in the location desired, which is of great importance. Owing to the desirability of carrying a large number of mines, these vessels are designed to be slow speed, of about nine knots. When planting mines submerged, the speed should not exceed one and one-half to two knots. As there is no wave motion at the bottom in ordinary weather, the mines can be carefully handled and planted. It has recently been reported by cable from London that the Germans were using vessels of substantially this type in planting mines off the English coast. The author, personally, however, has no authentic information as to whether a boat of this type has been built or not. He was informed that the Russian government contemplated building one, but since leaving there in 1910 nothing further was heard about it.

the guns of a powerful fleet, to protect its own entrances and harbors.

The submarine *Protector,* built in 1901 and 1902 at Bridgeport, Conn., was fitted with a diving compartment which corresponded to the mine-laying compartment of the 1905 design above referred to. The importance of a mine-laying submarine for the defense of the country was first officially called to the attention of the American people by a board of officers appointed by ex-President Taft (when Secretary of War), as early as January, 1903. This board of officers consisted of General Arthur Murray, late chief of Coast Artillery Corps (then Major), Captain Charles J. Bailey and Captain Charles F. Parker, of the Artillery Corps. The following is a copy of their recommendations for this type of vessel for the defense of our coast:

Conclusions and Recommendations—for the Defense

"First and second, the board believes that this type of submarine boat is a most valuable auxiliary to the fixed-mine defense, and in cases where channels cannot be mined owing to the depth, rough water, swift tides, or width of channel, it will give the nearest approach to absolute protection now known to the board. The boat can lie for an indefinite time adjacent to the point to be defended in either cruising, awash or submerged condition, by its anchors, or on the bottom ready for instant use, and practically independent of the state of the water and in telephonic connection with the shore, or can patrol a mined or unmined channel invisible to the enemy and able to discharge its torpedoes at all times. It possesses the power of utilizing its engines in every condition except the totally submerged and can always charge its storage batteries while so doing, necessitating its return to shore only when gasoline (petrol) must be replenished. In narrow channels the boat or boats would have a fixed position with a telephone cable buoyed or anchored at the bottom. In wide channels they would patrol or lie in mid-channel or where they could readily meet approaching vessels. Third, as a picket or scout boat, outside the mine field, or even at extreme range of gun fire, telephone communications can be sustained and information received, and instructions sent for attacking approaching vessels. Fourth, the test at Newport demonstrated the ease with which the boat can locate and pick up cables, and with minor alterations in the present model, junction boxes, etc., can be taken into the diving compartment and repaired at leisure while absolutely protected from hostile interference. The faculty possessed by the boat of maneuvering on the bottom and sending out divers leaves little or nothing to be desired in its facilities for doing this work.

"The boat shows great superiority over any existing means of attacking mine fields known to the board. First, it can be run by any field, as at present installed, with but little or no danger from the explosion of any particular mine or from gun fire, during the few seconds it exposes the sighting-hood for observations, and can attack at its pleasure the vessels in the harbor. Second and third, the board personally witnessed the ease with which cables can be grappled, raised and cut while the boat is maneuvering on the bottom; mine cables can be swept for, found and cut, or a diver can be sent out for that purpose. The crew of the boat is a skilled one, trained for its tests in every way likely to be requested by the Naval Board. It should be noted that, with one exception, no seamen are used, this exception being the man who steers and handles the boat. The crew is as follows: One navigator, who is also a diver, one chief engineer, one assistant engineer, one electrician, one machinist, one deck hand and one cook.

"The board recommends consideration of the foregoing by the General Staff. The question of the use of the Whitehead torpedoes as a part of the fixed-mine defense, fired from tubes on shore, is now receiving consideration. Where channels are

wide and water swift, this use of the Whitehead will be very limited. With boats of this type the Whitehead can, it is believed, be carried within certain effective range in all ordinary channels, and this alone will warrant the consideration asked for.

"The board recommends, in consequence of its conclusions, that five of these boats be purchased for use in submarine defense as follows:

"One for the School of Submarine Defense for experimental work, one for the eastern entrance of Long Island Sound, one for the entrance to Chesapeake Bay, one for San Francisco harbor, and one for Puget Sound.

"The necessity for this kind of defense in the four localities named needs no demonstration to those acquainted with them."

Arthur Murray,
Major, Artillery Corps, President.

The recommendations of this board were submitted to Congress and the Senate passed the bill for the purchase of the *Protector* to enable the authorities to test out the merits of this type of boat as an adjunct to our coast defense, but at this time certain politicians and financial groups were able to control the policy of the United States Government in its development of the submarine. These influences had been sufficiently strong to take out of the hands of the Navy Department or the officers connected with the Coast Artillery, who had charge of the laying of our mines and the protection of our coast from hostile invasion, the right to specify the kind of appliances they would use. Instead of leaving the question of defense of our country in the hands of the expert officers who had been trained to study the problem, Congress in this instance specified the exclusive use of a type of boat which did not possess the characteristics called for by these expert students of defense.

Strange as it may seem, the opportunity for the United States to be a leader in the development of the type of boat which Germany has proved to be of such great value, was lost by the diction of a manufacturer of gloves from an inland county. It is a sad commentary on our laws that such a state of affairs could exist, but I accidentally happened to learn that this was the case in this instance, and I fear it has been the case in many other instances where financial and political influences have been permitted to overrule the recommendation of officers of the army and navy.

The *Protector* had been built by private capital at the suggestion of the Board of Construction of the United States Navy, at that time composed of Admirals Melville, O'Neil, Bradford, Boles and Captain Sigsby. In 1901 I had been called to Washington by a telegram from the late Senator Hale, who was then chairman of the committee on naval affairs in the Senate, and was asked to submit plans and specifications for a submarine torpedo-boat. Accordingly, I submitted plans for the three types above referred to. The Board of Construction complimented me upon the plans and stated that they believed the plans of the vessels I proposed showed great superiority over any type of vessel that had been heretofore proposed, either in this country or abroad, but they stated that all appropriations made by Congress had specified the particular type of boat that must be used, and the Navy Department did not have any authority to authorize the construction of a different type, but that if I or my friends had sufficient capital to construct such a vessel, they would see that it had a fair trial upon its merits, and if it proved of value to the service they would recommend its adoption, and they did not believe that Congress would then ignore their recommendations. Consequently the *Protector* was built. Her performances and capabilities for defense of the United States were strongly endorsed by the Board of Officers which had tested her, and many of her characteristics have been copied by all European builders of submarines.

After the Senate passed the bill authorizing her purchase, the matter was referred to a sub-committee in the House. As she had been built by private capital and the life-time savings of a number of friends, as well as all my own capital, were tied up in her, I was naturally desirous to learn if the House Committee having the matter in charge was also going to recommend her purchase.

One day I called at the committee room to inquire. There was no one present in the main committee room, so I took a seat at the table. In a few moments, after sitting down, I heard a conversation in the chairman's room, adjoining the general committee room. Soon the voices took on an angry tone, and I heard one member of Congress accuse the chairman of the sub-committee having the matter in charge of intention to report unfavorably the recommendations for the purchase of the *Protector*. I recognized the voice of the gentleman who was making the accusation as that of an old retired general. He did not use polite language in accusing the chairman of the sub-committee of intent to defeat the purchase of the *Protector* in the interest of the company which had had sufficient influence to maintain a monopoly of submarine boat construction in the United States up to that time.

The chairman of this sub-committee did report unfavorably, as they planned, and, as I stated before, a manufacturer of gloves from an inland section of the country was able to defeat the recommendation for the adoption of a means of defense for this country which the best qualified officers in the United States service of both the army and the navy had recommended as of great value and superior to other defensive means known to them at that time. Recently this ex-member of Congress referred to was sentenced to imprisonment for attempt to defraud the government in other matters.

I am a great believer in the value of this type of vessel for harbor and coast defense work, and I believe that in one country vessels of this type are now engaged as mine layers in the present war. Our own government has to this day no submarine vessel equipped for the laying of mines, although the Commandant of the School of Submarine Defense repeatedly urged their adoption. I quote from the annual report of the Commandant of Submarine Defense, 1904-1905:

"As in the case of movable torpedoes, the question of the use of submarine boats as adjuncts to the fixed-mine defense of the country has been under consideration by the Board for the Revision of the Report of the Endicott Board during the past year, and the Torpedo Board has been called on for remarks on this subject.

"It is now again desired to invite special attention to the unquestionable value of submarine boats as an adjunct to fixed-mine and movable torpedoes for the defense of the particular places named in the report of the second committee; and also to the need of a boat of the LAKE type, or similar type, at the School of Submarine Defense for experimental work, as this is the only submarine boat, so far as known, that can be efficiently used in countermining electrically-controlled mines. The advisability of procuring submarine boats for the defense of the places named, it is believed, will also be seen to be unquestionable when it is considered that the cost of such a boat is about one-fortieth of that of a modern battleship; that without such boats as an adjunct to the mine and gun defenses of those places, a more expensive boat of the navy will undoubtedly be called for as a home-guard for those waters in case of war; and that with submarine boats as an adjunct to the army's defenses, it will be impossible to so defend those waters as to enable the more expensive and seagoing boats proper of the navy to cut loose from those harbors with impunity and go wherever naval strategy may demand."

(Signed) Arthur Murray,
Lieutenant-Colonel, Artillery Corps.

(To be continued)

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Some Defects in Installations of Marine Machinery and How They Were Remedied

The writer will endeavor to illustrate by means of sketches a few of the defects in marine machinery installations that have come under his observation from time to time and the means taken to remedy them, with the object of showing how a lack of running, or practical, experience on the part of the engine designer, or the parties responsible for the installation of machinery in the engine room, is often the cause of a good deal of expense in the upkeep of the engines and responsible for expensive overhauling. The writer commends, therefore, the following facts, though far from being unique, to engineers of small craft who may not often have opportunities for exchanging ideas on these points with others. Were it not for the fact that the noted firm with whom the writer is employed demanded high efficiency in the working and management of the various units at work in the construction of that big undertaking, the new breakwater and harbor works at Victoria, B. C., it might not have been within his province to discuss in this magazine some of these units with particular reference to one of the firm's steamers.

It was some years ago when, as a draftsman poring over the drawing board and plans of a destroyer's engines in the works of a well-known firm of Admiralty contractors, the writer had to concentrate his ideas upon some means by which the excessive vibration at high speed might be reduced, if not eliminated. The method adopted was the arrangement of various struts and stays between the engine cylinders and the ship's side frames, and vertical stays to the (light) deck overhead. The chief ship's draftsman, on coming around, wished to know whether certain stays from the engine were intended to support the deck, or was the deck intended through these same stays to support the engines? It certainly was not obvious, although what appeared so nice and pretty on paper was not of much use in practice. With some running experience a better appreciation might have been held as to the nature of the vibration, direction of forces and so forth.

These incidents, or accidents, outlined here from the writer's experience did not involve any nervous breakdown, nor could they be characterized as heart-breaking (although on one occasion before escaping into the engine room he was nearly asphyxiated by burning oil setting fire to the floor boards fronting the furnace), but it was sufficient to cause many an hour's overtime to be put in. We will now consider the plant under the respective headings:

Boiler

This was an ordinary tubular boiler of the marine type, with a steam dome and fired with oil fuel. It fell short, however, of local requirements as regards strength, inasmuch as the longitudinal stays were screwed into the combustion chamber, also the roof stays in the combustion chamber and the vertical stays in the dome. All therefore had to be cut out and nutted at each end. Now all this would add considerably to the strength of the boiler, yet the boiler's efficiency was originally sacrificed for the sake of a detail.

On looking at Fig. 1 it will be seen that the blow-down valve was situated right underneath the boiler and about 10 inches from the front end. Owing to the sagging down of the boiler on the chocks, the elbow rested on the

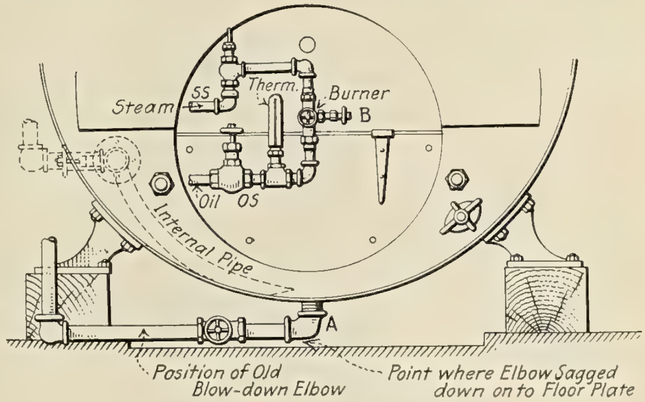


Fig. 1.—Oil-Burning Arrangement

floor plate, thereby setting up a shearing stress which caused the elbow to fracture at the point "A," causing an escape of steam which nearly scalded the engineer on watch.

I had this obsolete arrangement cut out and a flanged jointed valve fitted on to the boiler front, having an internal pipe leading from it to the lowest point inside, as shown by dotted lines.

Engine

The working condition of these engines was for some time a source of worry and gave considerable trouble, inasmuch as top and bottom connecting rod brasses wore

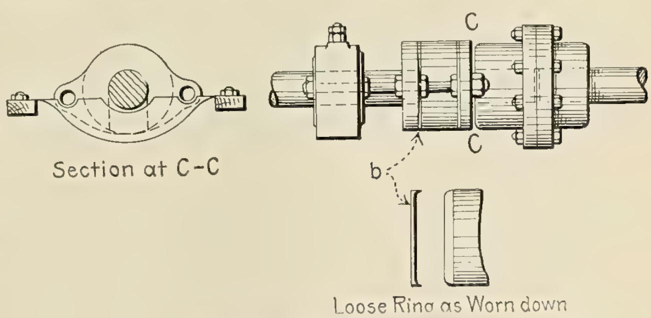


Fig. 2.—Thrust Rings and Collars

rapidly, and required adjusting every few days, while water for cooling purposes had frequently to be resorted to. The cause was eventually traced to the thrust. The first indication that there was anything wrong was the fact that the white metal rings on the ahead and astern sides of the thrust, respectively, rattled at times, sometimes revolving with the shaft, at other times remaining stationary.

Referring to the sketch of the thrust collar (Fig. 2) it

will be seen that the forward ring had worn to about one-half its original thickness, due primarily to the action of the sea water which played thereon and had caused corrosion and much eating away of the surfaces between the loose rings and thrust collar. Now this ring was a little larger in diameter than the thrust, so it had actually worn down to half its original thickness without apparent indication. Its periphery had become as if it were beaded over, as shown at *b*. These two very rough surfaces created a fore and aft vibration which accounted for the excessive wear and tear on the engine brasses.

The matter was remedied by having a bath of sheet iron in which the thrust might revolve; there was just space enough at "C" to allow one side of the bath to project into the space between the coupling and shoe, which would allow both sides of the bath to touch the shaft so that under ordinary working conditions the bath would always have a plentiful supply of lather. After this simple arrangement everything worked satisfactorily and the bearings, instead of having to be adjusted almost every other day, now ran for weeks. A side view of the bath is shown taken through "C C."

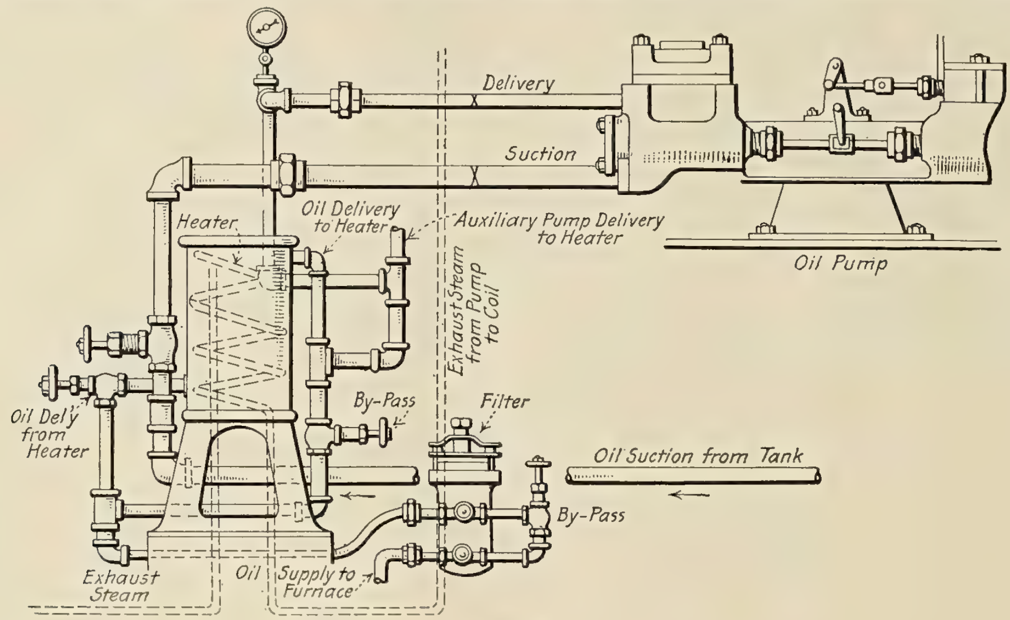


Fig. 3

Fig. 4.—This Arrangement was Introduced at Points X—X in Delivery and Suction Pipes, Fig. 3

Oil-Burning Arrangement

The oil fuel burning system in this boiler was that known as the "Thompson system," which might be said to consist essentially in the construction of the burner. Such a system is extremely simple.

We have an oil service pipe, *O S* (see Fig. 1) and a steam pipe, *S S*, leading to the burner *B*. The oil is heated up in the heater (see Fig. 3) by the exhaust steam from the oil pump by means of a coil therein to a temperature of about 180 degrees F. and pumped in at a pressure of about 145 pounds per square inch. It needs but a very small jet of steam to insure proper combustion, the valve, in fact, being merely off the face, while to increase the flame the valves for steam and oil would be opened a trifle more, say one-twelfth of a turn each. Dense volumes of smoke show that there is too much oil, and here is some advice that I would firmly impress on those who are inexperienced. Never open your oil valve first, but the steam jet always, otherwise the oil is apt to accumulate in the front end of the furnace and generate a gas and cause an explosion more than enough to be pleasant.

The engineer, who had to look after his fires as well as work the engines, often had to meet the difficulty of getting away from his operating levers to stop the oil pump when shutting down the fire, otherwise the oil pump would become overloaded and exceed the normal working pressure to the danger of bursting the oil service piping. To get over this difficulty and to avoid having to stop the pump, I introduced a by-pass arrangement (see Fig. 4).

Here you will observe a small spiral spring loaded valve which can be set to any desired pressure, any excess of which would leak through and pass to the suction side, so that during maneuvers the pump could be kept going at a uniform rate. Should the spring for any reason break, then the by-pass valve *B* could be closed and the oil supply continue as before.

If the brick arches in the furnace are still red hot, the burner will ignite without using a torch, but this is where one cannot be too careful. See that you do not have too much steam passing through the jet, for if any oil has been accumulating there is the danger of a back fire, and the burning oil may run on to the foot plates or be blown back out of the furnace without any warning. In case of danger and fire a control valve can be operated from the deck which cuts off the steam and oil supply, but that will not put a fire out if once it has got a hold.

The oil supply is filtered before it passes to the burner *B*, and by means of by-pass valves (see Fig. 3) the filter can be opened while under weigh for cleaning purposes, also should the steam heating coil burst the oil can pass without going through the heater. As the piping is turned

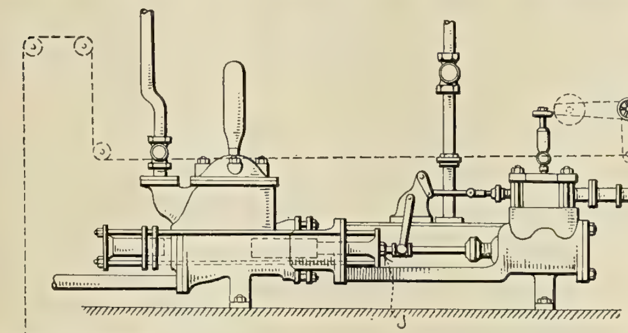
round 90 degrees in places for clearness, the course of the system may be rapidly carried out. A steam pressure of about 35 pounds per square inch should be enough to start the oil pump, and if the boiler is tight, it would take about eight hours for the steam to drop from 125 pounds to 40 pounds by the steam gage, which, of course, refers to raising steam on this particular boiler.

Feed Pump

Fig. 5 shows our double-acting feed pump, which doubtless was a good efficient pump under normal conditions, but very much "wanting" when the observer took it in hand. "Erratic" in behavior would be a mild term to qualify its remissness. As it had to pump against 140 pounds boiler pressure, the glands necessarily had to be fairly tight, but the pump would not work steadily and could be kept going only at a moderately quick speed, the result of which would be a rapid emptying of the hot well and a consequent racing of the pump, of course to the detriment of the boiler, as with the last few strokes air would be pumped in.

Invariably this racing would occur at the most inconvenient time, such that the engineer could not perhaps get away from the operating levers. At the first opportunity he would shut off steam and next wait his opportunity to start it afresh. This unsteadiness in working was responsible for the thread wearing away in the joint of the plunger and piston rod marked *J*, so that it ultimately came adrift. Strange to say, the pump, although not working well previously, was not then thrown out of commission, as the two near side plungers were still operating, the effect being to cause the off-side piston rod and near-side valve spindle to travel quicker, thereby causing the near-side plunger to do higher duty.

On taking out the plunger I carefully calipered the same and found it had slightly worn where the packing



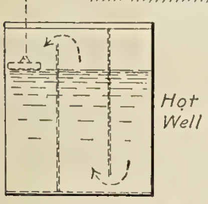
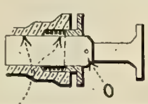


Fig. 5



Plunger Worn by Friction of Packing between Arrow Points

Fig. 6

rubbed, but not enough to justify condemning same. On thinking it out, however, I gathered that it took but a very slight obstruction when pumping at full load to stop the pump, and the almost imperceptible ridge on the plunger was the cause of the packing at this point getting extra compression. Also some of the packing got wedged in, as it were, between the plunger and neck ring at the bottom of the stuffing box. The fact that the plungers were cast hollow with a plug at the end was the cause of one drawing in air and discharging it through a sand hole at the point *O* (see Fig. 6).

I had the new plungers made solid and fixed up an automatic arrangement which regulated the speed of the pump according to the quantity of water in the hot well by means of a bell crank lever having six adjusting holes, bolted on the steam regulating valve, one arm having a cord attachment passing over guide rollers to a float in the hot well, the other arm being weighted, which caused the valve to open to steam as the float rose, the float being slightly weighted to counteract the weight of lever and weight. The plaintive cry of the watchman at irregular

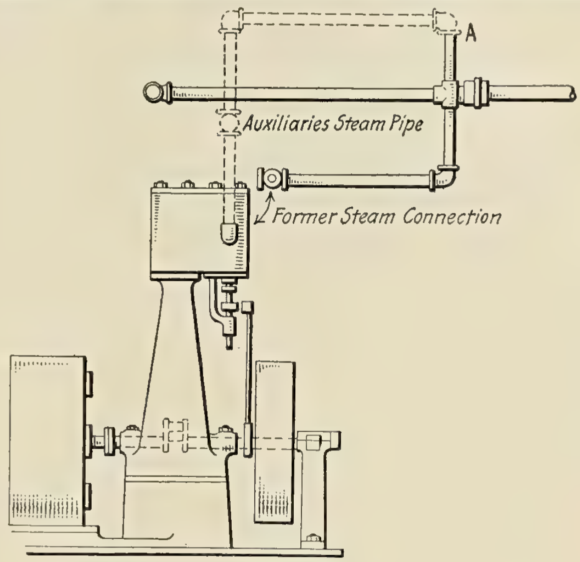


Fig. 7

intervals calling upon the gods became now a thing of the past!

Dynamo Engine

One would expect having some regard to the various statements made in text-books as to the proper location of a dynamo, taking into consideration that it is essential to select some spot higher than the bottom engine roof platform, that plenty of air should circulate around the armature, that it should be in a dry place, and so forth, that at least some horse sense might be displayed in arranging steam pipe.

Just refer to Fig. 7 and you will see here an instance where a dynamo has filled the function of a veritable water trap. Note the levels of the winch piping and dynamo steam piping respectively. Here we have all the condensed water from the steam pipe gravitating back to the dynamo, the result being that as there was no drain on the engine valve chest, the piston valve rings, as well as the piston rings, broke on two occasions when getting up speed, and the electric light was put out at a critical time.

As there was a short vertical length leading to point *A*, I had a new length of piping shown in dotted lines carried to the engine cylinder. There has been no trouble since, as the steam is now dry—comparatively.

Stanley Evans,
Chief Engineer, Sir J. J., Ltd., No. 10.
Victoria, B. C.

The Failure of Evaporators

On some of the latest battleships the United States Navy Department departed from its standard evaporator installation in an effort to secure compactness and extreme lightness coupled with high efficiency. A well-known, reliable firm modified its standard commercial evaporator and produced an equipment that fulfilled the department's requirements.

The installation here discussed consisted of four horizontal multicoil evaporators, piped for double effect opera-

tion, with ample distiller capacity, necessary pumps, heaters, traps and separators. A capacity of 28,000 gallons of potable water per twenty-four hours was guaranteed. On a capacity installation test it was found that with coils and steam manifolds free from scale the guaranteed capacity could be exceeded by 40 percent. No reliability or life test was run.

In order to secure high efficiency the designers and manufacturers used thin-coiled tubes of pure copper, provided a high steam pressure and velocity, and to secure lightness fined down the dome and shell plating and stiffeners to a minimum. Very small water and steam spaces were provided for the guaranteed output. Each unit was originally fitted with a baffle ring at the junction of the dome with the shell, a horizontal curved baffle plate in the upper part of the shell, and four vertical baffle and circulation plates parallel and close to the coil elements. The bottom blow connection and pipe was 2-inch.

The ship sailed from New York in April, having on board about 1,350 souls. The necessity of providing an ample supply of water for so large a number of men not yet trained to a seaman's economy in the use of fresh water, coupled with the fact that the vessel's machinery was new and untried, and the excessive makeup feed necessitated by numerous small leaks, made it necessary to operate the evaporators at maximum capacity on the run to Vera Cruz.

After the first four days of the voyage the output of the evaporators fell off markedly. During the three remaining days of the passage the diminution in output was progressive. When the vessel anchored the coils of the evaporators were withdrawn from the shells and it was found that the shells were filled to a depth of about eighteen inches with shale like salt, which had been cracked off the coils by blowing down, but which had not been forced out through the bottom blow, that the coils and manifolds were solidly incrusted with salt scale, and that the spaces in the spirals of the coils were filled solid with hard rock salt.

Thereafter, in order to maintain an adequate output it was necessary to give the evaporators a double blow every four hours; to fill them to the top of the upper manifold with salt water and let them soak for four hours out of every twenty-four; to give them an extra blow before starting up, and to haul the coils and scale once a week. This frequent scaling involved much labor and resulted in destructive distortion of the coils.

At the end of the third week after arrival at Vera Cruz, or within five weeks of total operation, one of the separators on the vapor line from the first effect evaporator corroded entirely through. The separator was of seamless drawn steel tubing one-half inch thick. The escaping vapor smelled strong of chlorine.

From this date internal fittings, baffles, vapor lines, fresh water lines, valves and separators were constantly failing, due to persistent, excessively active corrosion. Soon the coils began to develop pinholes and to fail at their joints; this, notwithstanding the frequent scaling and the renewal of zincs in both water and steam space.

At the end of about eight months of operation the vertical baffle and circulating plates were removed, hand holes were fitted through the lowest part of the front heads of the shells, and the pressure of the primary steam was reduced from 280 pounds to 150 pounds. The salt scale that could not be blown through the bottom blow connection was raked out through hand holes every other day. None of these changes had an appreciable effect in reducing corrosion, nor did the installation of air cocks on the separators produce more than local benefit.

Finally, having renewed coils, in addition to several renewals of fittings, dry pipes and baffles, the dome plating corroded through and the shell plating in the vapor space became greatly reduced in thickness; the I-frame stiffeners were entirely corroded away. The evaporator failed completely after about fourteen months' operation at high capacity.

About 65 to 70 percent of the coils and 50 percent of the manifolds are in the vapor space. Both water and vapor space are restricted. The evaporators were operated at high capacity. The water in the shells was constantly super-saturated with salts due to the accumulated salt scale that broke away from the coils in blowing down, but which lodged and remained in the bottom of the shells.

A chemical analysis of the deposit taken from upper manifold, made by Dr. J. P. Millwood, chemist, United States Navy, gave the following results:

	Percent
Magnesium (Mg)	3.02
Calcium (Ca)	1.38
Copper (Cu)	0.89
Zinc (Zn)	0.33
Iron (Fe)	0.23
Alkalies (Na and K)	....
Silica (SiO_2)	9.5
Chlorine (Cl)	21.37
Sulphate (SO_4)	8.15
Loss on drying at 105 degrees C.	49.5
Further loss on ignition	4.6

"It is faintly alkaline in reaction, and treated with water only chlorides and sulphates of alkalies, magnesium and calcium are soluble.

"The sample contains water and sodium chloride chiefly, with calcium sulphate, magnesium sulphate, magnesium chloride and basic compounds of magnesium, copper, zinc and iron."

From an examination of Dr. Millwood's report it is believed that the failure of the evaporator plant is due to the generation of large quantities of hydrochloric acid and nascent chlorine

It is believed that the quantities of these active gases are due to the large coil and manifold heating surface in the vapor space, to the rate at which the evaporators had to be operated in order to supply the ship with the necessary quantity of water, and to the fact that, immediately after blowing down, a large percentage of the salt scale that cracked off the coils found lodgment in the water space of the shell (owing to the inability to blow it overboard through the bottom blow pipe), thus effectually reducing the volume of water in the evaporator and tending to super-saturate sea water with the various salts contained therein.

In this connection the following excerpts are quoted from an article on "The Corrosion of Distilling Condenser Tubes," by Arnold Philip, B. Sc., A. M. I. E. E., Assoc. R. S. M. (Admiralty Chemist), which gives the methods of determining the amount of hydrochloric acid given off, together with a discussion of its injurious effects.

He says: "Under these conditions (conditions very similar to those described in this history of evaporator failure) the magnesium chloride present is decomposed, hydrochloric acid is evolved with the steam, and a strongly alkaline incrustation and also an alkaline brine are formed. . . . From the results given above, however, it is apparent that the rate at which an evaporator is worked or, in other words, the temperature of the primary steam, caused the amount of copper in the distilled water and therefore of the hydrochloric acid formed in the evaporator, to vary. The more the evaporator is pressed, the greater the amount of hydrochloric acid formed in a

given time. There is, further, some evidence to show that the evolution of hydrochloric acid from the salts in sea water may not only be caused by the heating of the saline incrustation on the heated steam coils, but that this acid may also, but to a much smaller extent, be given off from the incrustations formed on the lower sides of the evaporator shell, and also possibly even from the brine itself, and in a given form of evaporator the formation of free hydrochloric acid is favored by the high temperature of the primary steam coils and the strong concentration of the brine. To obtain the least quantity of hydrochloric acid from a given evaporator, it is therefore necessary to avoid too great a concentration of the brine by suitable adjustment of the sea-water feed and brine cocks, and also, and most effectively, to reduce the rate of evaporation as much as possible. Both of these methods of remedying the trouble are, however, faulty, for they both tend to render the evaporator inefficient. The best remedy is to only use evaporators with drowned steam coils."

From the above it appears that the experiences of the British Admiralty and of the United States Navy are very similar. It seems certain that in view of its experience the navy will revert to its former practice of installing evaporators of a drowned-tube type, of a more rugged construction, with a view to securing maximum reliability and life of operation rather than of securing the last fraction of economy. In these later evaporators the domes, coils and steam manifolds will be of composition. The first effect traps will be omitted, an auxiliary evaporator feed water heater will be installed to take care of drains from the first effect coils. By utilizing this heat from the coils to heat the feed, and by connecting the auxiliary exhaust to the first effect coils, so that the evaporators may be operated under low output conditions (in port or during overhaul periods) without using live steam, it is confidently believed the economy of the drowned-tube (or nearly drowned) will closely approximate that of the type here discussed.

W. B. Tardy,
U. S. S. *New York*. Lieutenant Commander, U. S. N.

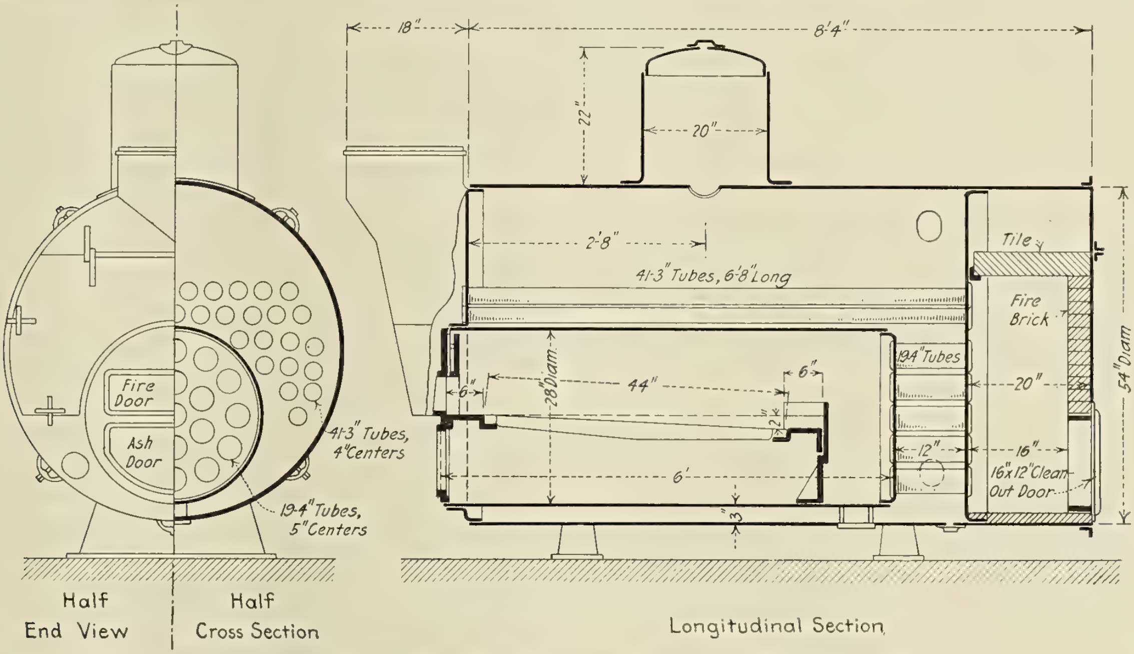
Keel of the California Laid.—The keel of the 32,000-ton battleship *California* was laid at the Navy Yard, Brooklyn, N. Y., on October 14.

Improved Type of Marine Boiler

The type of marine boiler shown in the illustration was designed to obtain better circulation, thereby increasing the amount of steam produced, or, in other words, the commercial horsepower, as compared with a boiler the same size but of the usual design.

The change made which was to accomplish this was to place a tube sheet in the rear end of the furnace and connect the furnace with the combustion chamber by 4-inch tubes. It was figured that this would set up a more rapid circulation than was possible by the usual method of attaching the furnace to the combustion chamber.

The test made was short and simply to determine what the boiler would do under unfavorable conditions. The shell was not insulated, the feed water very low in temperature and the coal as poor a grade of slack as could be imagined. It was figured that if the boiler would give the rated capacity under the most adverse conditions, it would be safe to assume that the performance under better conditions would be highly satisfactory. As the test was to determine the capacity of the boiler, or how closely the actual horsepower would agree with the designed horsepower, only such data were taken as would be of use in figuring the commercial horsepower, and these data were recorded with the greatest of care.



Dry Back Marine Boiler, with Tubes Between Furnace and Combustion Chamber

The boiler was set up in the shop, the stack projecting through the roof. During the test it was aimed to keep the pressure as near 100 pounds gage as possible, the safety valve being set for that pressure. The steam generated by the boiler did not perform any useful work, but was allowed to pass out through the boiler stop-valve into a pipe line placed alongside the smokestack and into the atmosphere. The feed water was carefully weighed by means of a barrel placed on a scale; from this barrel the water was allowed to run into a tank placed alongside the boiler. From this tank the feed water was picked up by an injector operated by steam from the test boiler and fed into the boiler. A thermometer was placed in this tank and the temperature of the feed water recorded every five minutes during the test.

On starting the test the height of the water in the boiler was marked by tying a string on the water gage glass; the test was stopped with the water at exactly the same

level as in starting. The condition at the start of the test was carefully noted and the test was stopped with the fire in the same condition that it was in starting, as nearly as could be judged. Natural draft was used, the stack being 40 feet high and 18 inches in diameter.

Summary of Test

Duration of test	1 hr. 34 m. 35 s.
Grate surface	8 5/9 square feet
Heating Surface:	
Furnace crown	21 square feet
19 4-inch tubes 12 inches long	18.62 square feet
41 3-inch tubes 6 feet 8 inches long	199.52 square feet
Back tube sheet (effective)	3.65 square feet
Total heating surface	242.79 square feet
Ratio H. S. ÷ G. S.	28.39
Average steam pressure by gage	95.05 pounds
Average steam pressure, absolute	109.75 pounds
Average temperature of feed water	45 degrees F.
Total water fed to boiler during test	1,845 pounds
Total water fed to boiler per hour	1,165 pounds
Quality of steam, percent	97
Water evaporated per hour, corrected for quality	1,130 pounds

$$\text{Factor of evaporation, } \frac{(H - t + 32)}{966.1} = 1.212.$$

Where H = total heat of steam at 109.75 pounds absolute = 1,183.9.

t = average temperature of feed = 45 degrees F.

Water evaporated from and at 212 degrees F. = 1,130 × 1.212 = 1,369.56 pounds.

The evaporation of 34.5 pounds of water from and at 212 degrees F. is considered equal to one boiler horsepower by the Committee of Boiler Tests of the American Society of Mechanical Engineers. Hence the horsepower developed equals

$$\frac{1{,}369.56}{34.5} = 39.7.$$

The builders had rated this boiler at 30 horsepower. Hence the percentage of rated capacity actually developed was

$$\frac{39.7 \times 100}{30} = 132\ 1/3 \text{ percent,}$$

or 32 1/3 percent above its rating.

As the builder in rating this boiler had used the standards of heating surface and grate surface which would ordinarily have been used for the usual type of marine boiler, and had never obtained such a high percentage above the designed rating, the excess was atributed to the only point of difference between the two types, namely, the 4-inch tubes connecting the furnace with the combustion chamber.

St. Louis, Mo. Arthur C. Meyers.

Lubrication Troubles

On a 20,000 horsepower reciprocating engine installation, fitttd with forced feed, a straight mineral oil was in use. The oil gave a test viscosity of 750 at 100 degrees F., cold test 5 degrees F., and being a straight mineral oil neither mixed nor saponified with water. The oil was in use for some months, giving excellent results—when suddenly trouble broke loose in the entire system. A thorough investigation failing to reveal any extraordinary circumstances that should lead to the oil failing to function properly, a sample of the oil was removed and carefully examined in the sunlight. It was evident that water was present, but after several days there was indication of settling.

The sample was then sent to a laboratory for testing. Here it was treated with gasoline (petrol), removing all the water from the oil and afterward reclaiming the oil. The reclaimed oil had a slightly burnt odor, with an indication of blown rapeseed. Upon mixing with water, it made the characteristic emulsion formed by mineral and blown rapeseed oils. It was quite evident that the original sample was a complete emulsion, caused by the mixing of the straight mineral oil with a compound oil.

The thrust bearings not being on the forced feed system, a compound oil made to saponify with water was in use here, and the layout of the oiling system was such that the probability of the two oils becoming mixed was so remote as to make it an impossibility. The forced feed system delivered to an enclosed crank pit. This crank pit was built so that it sloped forward, thus causing the oil to flow to a well fitted with two strainers—from which point the pumps picked it up and delivered it to the supply tank. The thrust bearing was well abaft the after end of the crank pit and about 1½ feet higher. The thrust was enclosed in an oil-tight box, open only at the top, and fitted with water-cooling coils, being in itself a separate system.

Further investigation showed that only the straight mineral oil had been put into the supply tank. This eliminated everything except the hand feed oil reservoirs, and it was here that the cause was located. It so happened that just before the trouble developed the ship was running at full power for some hours. At high speeds the valve gears require a generous oil supply, and during the full power period it was necessary to refill the oil reservoirs more frequently than usual. The usual supply was exhausted and the oilers went to the storeroom for more oil. Customarily the officer of the watch supervises the issuance of all oil, but under the existing conditions his other duties were predominant and he was unable to be present.

The compound oil, for use in the thrusts, was stored in 5-gallon tins, these tins being plainly marked so as to designate the oil. This particular oil was designated by its trade name and listed for the following uses: lubrication of reciprocating main engines and auxiliaries where oiling is done by hand, through wick feed or drop oilers. From all appearances this was the oil to use, so the working tank was filled with this oil, and from then on there was a constant flow of compound oil into the crank pits. Up to the time the trouble was discovered the total was in the vicinity of 50 gallons. However, this 50 gallons, about 12½ percent, resulted in a week of work and worry, as it was necessary to remove the 400 gallons in use, clean out the system and supply 400 gallons of new oil. The contaminated oil was stored for general and auxiliary use in the future, thus preventing a total loss.

The incident related above is only one of the many ways in which oils may become mixed. Oil is often received in 5-gallon tins, and there is every possibility that, in a large consignment, a few tins of strange oil may stray in, although the distributors take every precaution to prevent this. One safeguard is to obtain from the dealer, which he will gladly supply, a small sample case containing sample bottles of each oil that you have in use. Then, when supplying oil to the system, it is but a few minutes' work to remove a sample and compare its odor, color and general characteristics with the standard sample, thus removing all doubt as to the oil being O. K.

The writer has gone into considerable detail in discussing this matter, hoping to illustrate the necessity of detail in the management of oil, and especially as regards the ill effects of mixing, as illustrated in this case. It is hoped that this experience may be of value to others in the matter of saving themselves time, work, worry and money. D.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Compressive Strength of Metals

Q.—Why is the compressive strength of metals not given in the Tables of Strength? I see the tensile strength is always given but the tables have many blank spaces under the columns headed compressive strength.
S. S.

A.—The compressive strength for most metals is of less importance and is always much greater in magnitude. This, coupled with the difficulty of obtaining good determinations of it, probably accounts for its less frequent quotation.

Calculations for Thrust

Q.—(1) With a 120 horsepower oil engine running at 450 revolutions per minute and driving a boat at 20 miles per hour, what would be the approximate thrust in pounds upon the thrust collars?
(2) How is thrust calculated?
C. R. C.

A.—(1) About 1,670 pounds.

(2) Assuming that the 120 horsepower is brake horsepower and that the propeller efficiency is about 60 percent, which is reasonable for this type of propeller, there would be performed every minute $120 \times 0.6 \times 33{,}000 = 2{,}376{,}000$ foot pounds of effective work. This moves the boat through a distance of $20 \times 5{,}280 \div 60 = 1{,}427$ feet, so that if we have a force such that it produces 2,376,000 foot pounds of work in moving through 1,427 feet, the force is $2{,}376{,}000 \div 1{,}427 = 1{,}165$ pounds, which is the total thrust on the thrust block.

Energy and Work

Q.—Is *energy* the equivalent of *work?* Frequently I have noticed that the results of calculations of one or the other seem to be used interchangeably and I have not been able to reconcile the two. Work is force times distance, and energy (kinetic) is usually given as $\frac{1}{2} MV^2$.

A.—Energy is defined by the Encyclopedia Britannica as accumulated mechanical work. All kinds of energy are ultimately measured in terms of work. A body projected vertically upward (neglecting air resistance) will go to a height equal to

$$\frac{V^2}{2g}.$$

Therefore the *work done* when the body is at the top of its movement is

$$\frac{W}{g} \times \frac{V^2}{2g} = \frac{MV^2}{2g} = \text{kinetic energy.}$$

Heel Pieces

Q.—What are frame butt straps or heel pieces? Where are they fitted and why are they not used or fitted at the ends of a vessel? C. L.

A.—Lloyds rules for single bottom type construction require that "when frames are butted on the keel they are to have not less than 3-foot lengths of corresponding angle bars, fitted back to back, to cover and support the butts and be attached to the plating for at least three-fourths of the vessel's length amidship. Similar pieces of angle bar are to be fitted, if the frames are butted elsewhere." These are called heel-bars. At the extreme ends of the vessel the lower parts of the frames opposite to each other are lapped and riveted together; so no heel bars are needed, as there is no end butt with its attendant discontinuity of strength.

Coefficient of Moment of Inertia of Load Waterline

Q.—Please define the following expressions relating to a vessel's stability and give applications of same: Coefficient of moment of inertia at load waterline and coefficient of center of buoyancy above base. Please recommend some good text-book covering stability calculations, etc., of vessels.
L. T. D.

A.—Neither of these expressions are common in this country and their exact meaning is problematical. The coefficient of moment of inertia of load waterline is probably the fraction which the moment of inertia of the *actual* load waterline is of the moment of inertia of the *surrounding rectangle.* $I = clb^3$

where I = moment of inertia of load waterline
c = coefficient
l = length of load waterline
b = beam of load waterline

The coefficient of C. B. above base is probably the fraction of the draft that the C. B. is above the base.

C. B. above base = $c\,d$.
c = coefficient.
d = draft.

Stability calculations are well covered in most standard text-books on "Theoretical Naval Architecture," such as Peabody's, Biles', White's or Attwood's; this last * is the least expensive and is excellent.

* Theoretical Naval Architecture. By E. L. Attwood

Solid Steel vs. Wire Wound Guns

Q.—(1) What are the advantages and disadvantages of a solid steel and wire-wound gun of big caliber? I have read so many different opinions on this point I am anxious to know the correct facts.

(2) What are the advantages and disadvantages of a gun composed of an inner tube whose exterior diameter is decreased towards the muzzle due to a slight taper, round which is an outer tube continuous over the whole length and into which the inner tube is adjusted, after which comes the wire, etc., as compared with a gun composed of an inner tube, over which come different tubes which are shrunk on, and then the wire, etc.
C. R.

A.—(1) In the wire-wound gun the wire is wound in layers around an inner tube of steel. Each layer is wound with a different tension of the wire, and each exerts a compression on the layers which are inside of it. The result is that, when completed, the outer layers are in extension, gradually diminishing to the inner layers, which are in compression, all within the elastic limit. As wire can be made of enormous strength (as much as 200,000 pounds per square inch tensile strength), this type of gun is the strongest for the same weight of any yet developed.

No wire-wound guns are in use in the United States Navy. The British Navy uses them extensively, but they are now building built-up guns. The United States Army

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

uses wire-wound guns to a considerable extent, one reason for their use being their relative cheapness. The wire can be bought, at the present time, for about nine cents (0/4) per pound, whereas the forgings cost about thirty cents (1/3) per pound. The great disadvantage of the wire-wound gun is its insufficient longitudinal strength. This defect has never been fully overcome, and in large guns the prevention of "droop" is apt to become the dominating factor in the design.

(2) The answer to the second question is too involved and technical to be properly answered in this column. I would suggest that it be referred to some ordnance expert or publication.

Motive Power for Submerged Operation of Submarines

Q.—Will you please tell me if there is any good reason why internal combustion engines cannot be used for submerged operation of submarines, if compressed air or oxygen were carried compressed to small volume in steel flasks. I suppose there is some good reason or else the duplication of power plants would not be made. Also I should greatly appreciate it if you could, without taking up too much time or space, give a brief outline of the recent arrangement in the French submarines which permits them to use, as I understand it, their regular steam engine propelling unit when submerged. N. O.

A.—A storage of air or oxygen in sufficient quantities to permit under water operation for any reasonable length of time requires excessive weight and space, and, further, the discharge of the products of combustion is apt to lead to the detection of the boat. The French plan, as proposed by M. de Equeville,* is to use an ordinary boiler with oil fuel and a steam engine on the surface, but when submerged the exhaust steam is led to a concentrated solution of sodium hydrate, which absorbs the steam. This absorption is chemical and there is much heat evolved, and it serves as the heating unit in a secondary "soda" boiler. This process continues till the soda solution is saturated when the boat must come to the surface. On the surface steam is again obtained from the primary boiler, the soda solution may again be concentrated by evaporation of the water which it has absorbed, and the boat is ready for another submerged run. This plan offers the advantages that there is no change of propelling motor, the same engine being used under water as on the surface, and there are no products of combustion. The machinery can be forced without difficulty and relatively high power obtained both in light and submerged condition. No electric motor is needed. On the other hand, the system requires the addition of special soda boilers and a hot water reservoir; the plant occupies so much space that the available weight cannot be fully utilized; the center of gravity of the machinery is high and requires extra ballast to be carried; the radius of action on the surface is necessarily smaller than with an explosion motor; there is likely to be a strong corrosion of the boiler due to the soda, and isolation for heat will probably cause difficulties. The soda boiler installation appears, nevertheless, more promising than other power plants so far proposed for this purpose.

* See article on "Submarines," by G W. Hovgaard. Science Conspectus, 1915.

Repairs to Piston Ring

Q.—What would be the best thing to do if the high-pressure piston ring of a compound engine broke at sea? C. H.

A.—In the case of Ramsbottom rings, if broken in only two or three pieces, the best thing to do would be to continue to use the rings. If, however, they were broken into a greater number of pieces, holes should be bored in the ends and dowel pieces inserted. If the rings are badly worn, a piece of asbestos tape could be wrapped around the bottom of the groove to hold up the ring and prevent its breaking. In the case of a deep, flat ring, a plate can be attached to the inside in the form of a patch.

Some Results from the Working of Steel Plate

Fig. 1 is a photograph of a portion of a large plate of open hearth steel from a well-known maker. The plate was 80½ inches wide, 105 inches long and 1 inch thick. It was punched with four groups of 10 holes each, arranged so that there was a group of holes near either end of each long edge, one group showing in the photograph. These holes were 1 inch in diameter and were pitched 3 inches apart. After the completion of the punching operation, a 2¼-inch flange was turned along each of the short edges, and a portion of one of these flanges is also shown

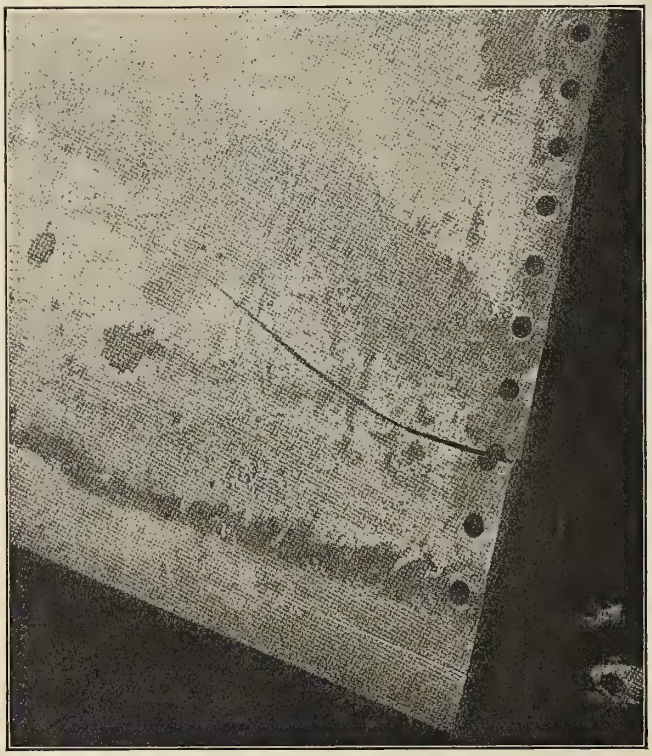


Fig. 1.—Cracked 1-Inch Plate

in the illustration. A close study of the picture will disclose the line of heating back of the turn of the flange, and will show that it did not extend very far back into the plate. The flanging was completed at just about six o'clock in the evening, and so the plate was set aside over night. In the morning, when the workmen started to resume operations on this particular job it was discovered that during the interval a crack had developed, as is shown in our view. This crack extended from the third rivet hole, which was 12 inches back from the turn of the flange, 34 inches into the plate, terminating at a point 22 inches back from the flange. The crack stood open at the plate edge about ¼ inch, and the portions of the plate were sprung so that the two edges of the crack were separated about ¼ inch in a direction perpendicular to the surface of the plate. The plate appeared and worked like good, soft material. The buttons punched from the holes stood up well when they were hammered down flat.

Several possible causes for such a behavior suggest themselves, but in the absence of information which could only be arrived at by a careful microscopic and chemical study of the material in the neighborhood of the failure, we hesitate to pronounce an opinion, preferring to leave the matter open to the discussion of those interested.—*The Locomotive of the Hartford Steam Boiler Inspection and Insurance Company.*

Marine Articles in the Engineering Press

**New Steam and Motor Ships of Special Types Described—
Method of Tabulating and Plotting Engineering Calculations**

An Ice-Breaking Train Ferry Steamer.—The twelfth ice-breaking steamer to be built by Armstrong, Whitworth & Company, Ltd., of Walker-on-Tyne, is the *Prince Edward Island,* 285 feet long between perpendiculars, 52 feet molded depth and a mean draft of 18 feet, with a total load of 650 tons of cars and coal. The vessel is designed to transport trains across the Straits of Northumberland in Canada, a distance of some 9 miles. The chief condition called for in a ship that is to act as an ice-breaker is material strength. In this case the strength is obtained by very close and massive frames spaced only 12 inches apart throughout the length of the ship. Amidships they extend downwards from the main deck to just above the tanks, while at the ends they go completely around. Three heavy stringers are carried, all fore-and-aft, the upper one merging into a complete deck beyond the engine rooms. The plating for about 6 feet above and below the waterline is 1 inch thick and is flush throughout with an internal seam strap, over which the frames are joggled. The stem and stern frames are heavy steel castings into which the plating is rabbetted, the stern proper being 9 inches by 3 inches in section. On the waterline the angle of the plating is not vertical to the water plane, but flares at an angle of between 20 and 30 degrees, so that the pressure of the ice tends to lift the hull bodily up instead of crushing it. The section of the ship is such that the vessel will have a tendency to roll, which is of considerable advantage in an ice-breaker. The main deck forms the platform for the rails and is entirely open aft, the ship being backed into a dock and, when made fast, a drawbridge is lowered on to the down-curve stern and butts against the end of the rail deck. A full load of cars immerses the ship about 18 inches. The arrangements for bunkering the ship are such that coal cars are run down the rails and discharge their hoppers direct down through big doors between the rails into the cross bunkers. Very comfortable and spacious passenger quarters are provided on an upper promenade deck, with dining room, lounge, smoking room, etc. The propelling machinery is exceptionally strong. The propellers are of the sectional type with blades of nickel steel of very strong section and stubby form. A good supply of spare blades is carried on board. Twin screws are provided aft, and, in addition, a propeller is fitted forward to draw away the water from under ice ahead and also to aid in berthing the vessel in a dock chocked with ice. The main engines driving the twin screws give a total of 5,000 indicated horsepower at 110 revolutions per minute with cylinders 23½, 37½ and 60 inches diameter by 39 inches stroke, while the forward set gives 2,000 indicated horsepower at 125 revolutions per minute with cylinders 21, 33½ and 54 inches diameter by 36 inches stroke. Steam is supplied at 180 pounds pressure by three single-ended three-furnace boilers, fitted with Howden's forced draft. Special features developed by Armstrong, Whitworth & Co., Ltd., have been incorporated in the machinery arrangement, details of which are withheld. One device is an arrangement for keeping the water inlets to the circulating pumps clear of ice. Also arrangements are made for the application of heat to the ice surrounding the ship. Furthermore, provision is made to prevent the action of sand in wearing the stern glands when working in shallow waters. 8 illustrations. 3,600 words.—*The Engineer,* July 16.

Calculating Tables for Shipbuilding and Marine Engineering.—The article deals with the practice of representing the results of calculations with formulas in the form of tables and diagrams. It is pointed out that it is possible to introduce successively new values of one factor in a formula and present the subsequent result in the form of a curve or straight line over a system of ordinates, or even in a simple table with parallel columns. A method is also shown by which it is possible to correlate graphically three, or even more, factors or functions by setting them off on parallel bases and to connect the related points by lines. The author has found the method convenient for rapid determination of admiralty coefficients of speed, of the French midship section coefficients of speed, of diameter of propellers, of mean effective pressures of steam condensing and exhausting engines and of safety valve springs; further, have they proved themselves useful for the horsepower formula of Afonasieff, the calculation of propeller slip, the helicoidal area of propeller blades, the indicated horsepower of steam engines or other calculations in any field of engineering. 25 illustrations. 3,000 words.—*Schiffbau,* August 25.

The Schoolship Grandduke Fredrich August.—A description is given of the third schoolship of the German Schoolship Association, of the above name in honor of its honorary president, launched January 14, 1914, and accepted and placed in service April 30. She serves, like her predecessors, solely for the training of boys for subsequent employment as sailors on board steamers and of a limited number of cooks. The ship is stated to be built in accordance with the highest requirements of the Germanic Lloyd, of the dimensions: 243 feet 4 inches by 42 feet by 24 feet 5 inches by 17 feet mean draft, with 1,695 tons gross and 747 tons net and a displacement of 2,363 tons. A Diesel engine of 400 horsepower at 165 revolutions per minute can drive the ship at 8 knots speed. The crew, including officers, numbers 271, of which 200 are boys. The ship, in the customary shape of sail ships with clipper bow and elliptical stern, is rigged as a bark with double topsails. The lower masts and principal yards are of steel and the rigging of wire or manila rope, to serve a sail area of 22,000 square feet in a double set of sails. The hull is constructed of steel, which is also employed for large parts of the decks under the wood. Six watertight bulkheads without doors divide the ship. Aft are the staterooms and office of the captain and the officers in compartments I and II. Number III is given to the engine and machinery, while IV and V are quarters for the boys, provision being made for 240 of them; the holds below are used for storing provisions and stores. A donkey boiler with bunker is also placed in compartment V. Compartment VI is devoted to quarters for petty officers above and to storerooms below. In compartment VII is a special fireproof paint room. Ballast is provided by 400 tons stone and 100 tons pig iron. Careful provision is made for fire mains, sanitary arrangements, bilge pumping, electric light and storage battery, 9 boats with capacity for 272 men, anchors, chains and wireless telegraphy. The machinery plant comprises a main engine of four-cylinder, two-cycle Diesel type, with scavenging through exhaust slots and three-stage air compressor and cooling pumps attached to the main engine. An auxiliary compressor is

driven by an independent two-cylinder, four-cycle Diesel engine with fire pump attached. Fuel is carried in three tanks of about 80 tons capacity. The propeller can be uncoupled for sailing. A small machine shop with necessary tools serves for necessary repairs. 17 illustrations. 4,100 words.—*Zeitschrift des Vereines Deutscher Ingenieure,* August 7.

The Motorship Pacific.—The great strides that have been made in the construction of motorships are shown by the record of the firm of Burmeister & Wain in Copenhagen, who had built until the beginning of this year fourteen ships, each from 6,550 tons to 9,700 tons cargo capacity, with horsepowers each from 2,000 to 4,000, and who have under construction twenty-three further ships, all with four-cycle Diesel engines, with which the firm has had remarkably fine experience. The *Pacific* had her official trial trip in December last and was immediately placed in service for South American trade. She is 366 feet by 51 feet 7 inches by 23 feet 3 inches draft, with a cargo capacity of 6,550 tons. The arrangement shows the engine room well aft, but still keeping a small cargo hold aft of it, otherwise the arrangement follows that of the average freighter. The machinery installation comprises two six-cylinder reversible four-cycle main Diesel engines of 21¼ inches bore by 28¾ inches stroke each, which can furnish collectively about 2,000 horsepower. The engines are inclosed and fitted with pressure oiling, mixing of cylinder and lubricating oil being prevented by a stuffing-box below the single-acting, open-ended cylinder. The valve gear is reversible by sliding the cam shaft and substituting a special set of cams for reversing. Each cylinder has its own fuel pump, which draws from day settling tanks of twelve-hour capacity. The auxiliaries comprise two four-cycle Diesel engines of about 200 horsepower at 225 revolutions per minute, driving each a dynamo and a compressor for air of 300 to 375 pounds pressure, stored in two reservoirs for starting purposes. Each main engine has a high stage compressor taking 300 pounds air and compressing to 880 pounds. All pumps are driven electrically, five centrifugals and two reciprocating. All winches are driven electrically, with 220 volt current, which by a rotary transformer is reduced to 110 volts for the lighting. Emergency or night lighting at 110 volts is furnished by a little two-cycle crude oil engine, which can give current also to a small high-pressure air compressor for the emergency of a total loss of all air. Heating is provided by a small oil-fired donkey boiler. The exhaust lines have double muffling, one at each engine and one in a deck house above with branches to the masts. The total weight of the machinery plant is given as 440 tons. The engine room is 40 feet long, about 26½ feet shorter than a steam engine room would be. Fuel economy in carriage is an advantage, as a round trip of three months to South America can be made with 700 tons oil instead of 1,700 tons coal with a cargo increase of 1,000 tons. The trials showed 11.41 knots at 2,033 horsepower at 153 revolutions per minute at a fuel consumption of .679 pound oil per horsepower hour. 10 illustrations. 1,700 words.—*Zeitschrift des Vereines Deutscher Ingenieure,* August 21.

The First Year at Panama.—By Winthrop L. Marvin. All told the net canal tonnage on which tolls are based on vessels traversing the Panama Canal during the twelve months ending July 31, 1915, was 4,404,364, of which by far the greatest single element was the wholly American coast-to-coast tonnage of 1,416,294. In addition to this coastwise fleet, other American cargo vessels made a certain number of foreign voyages, particularly in the trade to and from the west coast of South America, where they were employed because of war effects on European tonnage. Throughout the Government fiscal year, ending June 30, 1915, the tolls paid at Panama by the ships of all nationalities in all trades amounted to $4,343,383 (£892,-500), while the actual cost of operation for the same period was $4,112,550 (£844,000), so that, making no allowance for interest on the capital invested, depreciation, etc., the canal was superficially self-sustaining. The Panama Canal has entered directly into the calculations of every merchant who has built an ocean-going ship in the past three or four years on the Atlantic or Pacific coast of the United States, and the same influence has been potent on the Great Lakes. No single cause has done so much in this generation to add first-class steel steamers of an ocean type fit for auxiliary naval use to the American merchant marine. Prominent among the American steamship companies building vessels for Panama Canal trade are the American-Hawaiian Steamship Company, W. R. Grace & Co. and the Luckenbach Company. Attention is called, however, to the fact that there is not one American steamship service that goes through the canal and out upon the Pacific to South America, Australasia or the Orient. Only an occasional ship bound on a single voyage traverses the canal in international commerce. The reason why not a single American steamship has been, or is being, built for Panama-Pacific international commerce is simply a matter of wages and tolls for the operation of the ships through the canal. The steamship lines of other countries are so thoroughly subsidized by their own governments that the handicap of tolls and wages for the crew is reduced to a minimum and under the present conditions makes direct competition of American ships for this trade practically impossible. 3 illustrations. 2,200 words.—*The American Review of Reviews,* September.

The Turbine Installation on Torpedo Boats of the New Spanish Navy.—This article supplements a previous article published on May 1, 1914, in which a description was given of the first series of torpedo boats built for the new Spanish navy in which the machinery consisted of a three-shaft arrangement driven by turbines arranged three in series, the high-pressure and intermediate turbines driving respectively the starboard and port shafts, while the low-pressure turbine operated the center shaft. In the second series of torpedo boats, with which this article deals, the vessels correspond exactly in dimensions, armament and general features with those of the first series, but the machinery consists of a twin-screw arrangement, the turbines being of the Parsons impulse and reaction type constructed by the Cartagena Arsenal by the Sociedad Española de Construcción Naval. The high-pressure ahead turbine drives the port shaft and has at its forward end an impulse wheel to deal with the high-pressure steam. The low-pressure turbine drives the starboard shaft. The astern turbines are incorporated in the aft end of the high-pressure and low-pressure ahead turbines, both having both impulse and reaction blading. In both series of boats the total weight of all machinery was 75 tons and the space occupied by the machinery was the same. The diameter of the propellers on the second series of boats was 3 feet 7¼ inches and the pitch 3 feet 2½ inches. The designed speed of the boats was 26 knots with the turbines developing 3,750 horsepower. On the trials of the first boat of the first series a speed of 27.297 knots was realized. It is expected that the twin screw vessels will do as well as the triple screw boats. 21 illustrations. 1,200 words.—*Engineering,* October 1.

NATIONAL MOTOR BOAT SHOW.—The 1916 New York National Motor Boat Show will be held in the Grand Central Palace, New York City, January 29 to February 5.

Shipbuilding and General Marine News

**Contracts for New Ships—Marine Terminal Improvements—
Recent Launchings—Improved Appliances—Personal Items**

In addition to Government contracts amounting to $13,563,943 (£2,780,000) for the construction of six torpedo boat destroyers and sixteen submarines, which were placed during the past month, an unusually large number of orders for passenger and freight steamships and oil tankers have been placed with shipbuilders on both the Atlantic and Pacific coasts, and also on the Great Lakes. In addition to this, in those yords on the Atlantic coast where the facilities are especially adapted for repair work, an exceptional amount of repair work has been taken in hand, in many cases to the exclusion of new construction. As was to be expected from the present naval policy, four different navy yards, two on the Atlantic and two on the Pacific coasts, have been given contracts for a part of the new naval program.

The new merchant vessels contracted for during the month are for the most part vessels above medium size, running from 9,000 to 12,000 tons. No less than three vessels of 12,000 tons have been contracted for on the Great Lakes, and the two latest orders placed on the Atlantic coast, which were from the Standard Oil Company of New Jersey, called for vessels of about 12,000 tons.

Contracts for New Ships

Contracts for the six torpedo boat destroyers authorized by the naval appropriation of 1915 have been placed as follows: Two with the William Cramp & Sons Ship & Engine Building Company, Philadelphia; one each with the Bath Iron Works, Bath Me., and the Seattle Construction & Dry Dock Company, Seattle, Wash.; and one each with the Mare Island Navy Yard, San Francisco, Cal., and the Norfolk Navy Yard, Norfolk, Va.

Awards for the sixteen submarines authorized by the last Congress have been made as follows: Eight to the Electric Boat Company, New London, Conn.; three to the Lake Torpedo Boat Company, Bridgeport, Conn.; three on the Lake Torpedo Boat Company's designs to the California Shipbuilding Company, Long Beach, Cal., and one each to the Portsmouth Navy Yard, Portsmouth, N. H., and the Puget Sound Navy Yard, Puget Sound, Wash.

The Harlan & Hollingsworth Corporation, Wilmington, Del., has received a contract from the Standard Oil Company of New Jersey for two oil tank steamships, one of which is of about 12,000 tons.

The Seattle Construction & Dry Dock Company, Seattle, Wash., has received another contract from the New York & Cuba Mail Steamship Company (Ward Line), New York, to build a freight steamship of 5,000 tons deadweight carrying capacity.

The Fore River Shipbuilding Corporation, Quincy, Mass., has received a contract from the Texas Company, New York, to build two oil tank steamships, each 415 feet long, with a deadweight tonnage of 9,100.

The Union Iron Works, San Francisco, Cal., has received a contract from the Matson Navigating Company, San Francisco, Cal., to build a passenger steamer costing about $1,000,000 (£205,000) to ply between San Francisco and Honolulu.

The New York Shipbuilding Company, Camden, N. J., has received a contract from the Coastwise Transportation Company, Boston, Mass., to build a 12,000-ton steamship.

The Maryland Steel Company, Sparrows Point, Md., has received a contract to build two freight steamers for the A. H. Bull Steamship Company, New York, to cost about $800,000 (£164,000).

The American Shipbuilding Company, Cleveland, Ohio, has received a contract from the Interlake Steamship Company, Cleveland, Ohio, to build a 12,000-ton steamer.

The American Shipbuilding Company has also received a contract from the Pittsburgh Steamship Company, Cleveland, Ohio, to build a 12,000-ton freight steamer.

The Great Lakes Engineering Works, Detroit, Mich., will also build a 12,000-ton steamship for the Pittsburgh Steamship Company.

The Toledo Shipbuilding Company, Toledo, Ohio, will build four steel auxiliary schooners for the Smith Shipping Company, Inc., New York. These ships will be 261 feet long and have been designed by Cox & Stevens, of New York.

The Pusey & Jones Company, Wilmington, Del., has received a contract from the Philadelphia & Reading Railway Company, Philadelphia, Pa., to build a tugboat.

The Ellicott Machine Corporation, Baltimore, Md., has received a contract from the Pennsylvania Railroad Company, Philadelphia, Pa., to build three steel tugs.

A. C. Brown & Sons, Tottenville, Staten Island, have received an order from the Virginia Pilots Association, Norfolk, Va., for a new auxiliary schooner, designed by Cox & Stevens, New York.

The Manitowoc Shipbuilding & Dry Dock Company, Manitowoc, Wis., has received a contract for the construction for the U. S. Coast and Geodetic Survey steamer *Surveyor,* to cost $220,000 (£45,000).

W. M. Abbott, of Milford, Del., is building a wooden steam lighter for the Johnson Lighterage Company, New York.

William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., has received a contract from the New York & Cuba Mail Steamship Company (Ward Line), New York, to build two 9,000-ton steel passenger and freight steamships. These vessels were designed by Theodore E. Ferris, 30 Church street, New York.

The Harlan & Hollingsworth Corporation, Wilmington, Del., has received a contract from the Baltimore & Carolina Steamship Company, Baltimore, Md., to build a steel hull freight steamer 250 feet long, for service between Baltimore, Georgetown, Charleston and Wilmington.

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has received a contract from the Munson Steamship Line, New York, to build a freight steamship to cost about $625,000 (£128,000).

The Chester Shipbuilding Company, Chester, Pa., which is building a shipyard on the site of the old Roach property, is reported to have secured an order for an oil tank steamship, to be fitted with steam turbines and mechanical reduction gear.

The New York Shipbuilding Company, Camden, N. J., has received a contract from the New York Central & Hudson River Railroad Company, New York, to build four steel car floats.

The Staten Island Shipbuilding Company, Port Richmond, N. Y., will build four steel sea-going barges for the J. B. King Company, 17 State street, New York. These

barges will be equipped with oil engines furnished by the Bolinders Company, New York.

The Staten Island Shipbuilding Company has also received contracts to build one steel lighter each for the New York Central & Hudson River Railroad Company and the Pennsylvania Railroad Company.

W. & A. Fletcher Company, Hoboken, N. J., has received a contract from the New York Central & Hudson River Railroad Company to build one steel tugboat.

It is reported that the Maryland Steel Company, Sparrows Point, Md., has received a contract from the Spanish-American Iron Company, Philadelphia, Pa., to build a 450-foot freight steamship.

Alonzo Parks, Bath Me., will build a 90-foot wooden passenger steamer for the Moosehead Lake Steamboat Company.

Salvage Operations at Seattle

Interesting salvage operations were carried out last month in the center of Seattle's harbor in an effort to raise the freight and passenger steamship *Admiral Watson*, which was rammed and sunk about two months ago. The salvors made careful preparations, and although several trials were made with the pumps, it was found that the submerged hull was not tight and further work by the divers has been necessary.

Steamer *Admiral Watson*, Sunk in Seattle Harbor

The accident occurred while the *Admiral Watson* was loading cargo at the municipality's Bell street wharf for the Alaska Engineering Commission, to be used in the construction of the government railroad from Knik into the interior. The vessel had about 200 tons of steel rails and lumber aboard when the steamer *Paraiso*, owned by the Long Beach Steamship Company, and under time charter to the Pacific Coast Steamship Company, of Seattle, collided with her. A hole 18 feet in length was stove in the *Watson's* starboard side abreast the after hatch and she sank within a short time.

The contract for salving was awarded to the Seattle Construction & Dry Dock Company, of Seattle.

Shipyard Improvements

Lists and quotations on machinery and equipment for installation in the $5,000,000 (£1,015,000) shipbuilding plant which the Continental Dry Dock & Shipbuilding Company plans to establish have been asked by the General Erecting & Improvement Company, 9 East Fortieth street, New York. This company has the entire contract for the construction of this plant, but will sublet the greater portion and will, therefore, be interested in correspondence with engineers and contractors in connection with the many contracts with it states will be embodied in the blanket contract for complete construction.

William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., will spend in the near future about $700,000 (£143,250) for improvements and additions to its plant, consisting of rearrangement of portions of the yard, the construction of new buildings and the enlargement of some of the shipways.

The New York Shipbuilding Company, Camden, N. J., has been granted a permit for a one-story frame and iron storage building, 83 feet by 89 feet.

The Lake Torpedo Boat Company, Bridgeport, Conn., has taken out a permit for a building 90 by 240 feet, with an ell 60 by 60 feet.

The Lauritzen Transportation Company, Antioch, Cal., has purchased the Jarvis Shipyards, Antioch.

The Newburg Shipbuilding & Manufacturing Company, Inc., has been organized at Newburg, N. Y., with a capital stock of $150,000 (£30,800). The incorporators are Benjamin B. Odell, Jr., Frank N. Bain and A. L. J. Miller, all of Newburg.

The Robins Dry Dock & Repair Company, Erie Basin, Brooklyn, N. Y., will enlarge its shipbuilding plant at a cost to exceed $100,000 (£20,500), with the intention of being able to repair vessels of all sizes from a small tug to the largest transatlantic liner. This company is now converting the steamers *Kroonland* and *Finland*, of the Red Star Line, into oil burners.

New Steamship Company Enters the South Atlantic Trade

American and English shipping interests are forming plans to enter the South Atlantic steamship field on an extensive scale. To this end the American Merchant Marine Company has been organized under the laws of Delaware with a capital stock of $3,000,000 (£615,000). The general management of the enterprise will be under the supervision of Bowring & Co., 17 Battery Place, New York.

The new service, according to reports, will first enter the coastwise trade and will be known as the Southern Cross Line. Later it is the intention of the management to extend operations to the Gulf ports and also to South American ports.

It is planned shortly to place contracts for seven freight and passenger steamers.

S. S. Plymouth, 335 Feet Long, 55 Feet Beam and 34 Feet 6 Inches Depth, Built by the New York Shipbuilding Company at Camden, N. J., for the Coastwise Transportation Company, Boston, Mass.

New Steamship Lines

The Edenton & Chowan Steamboat Company, with a capital of $50,000 (£10,250), has been organized at Elizabeth City, N. C., by A. S. Foreman, A. S. Daniels and R. E. Black.

The Red River Navigation Company, capital $50,000 (£10,250), has been organized at Shreveport, La., by W. K. Henderson, O. A. Wright, J. C. Abel and F. D. Lee, to operate a line of barges on the Red River.

The Occidental Steamship Corporation has been organized in the State of New York, with a capital stock of $1,000,000 (£205,000). Winslow, Keenan & Budd, New York, are attorneys for the corporation.

Witherbee, Sherman & Co., Port Henry, N. Y., who operate iron ore companies, are planning, it is reported, to make shipments by water when the new Champlain Barge Canal is completed. This, if true, will render necessary the construction of a large number of steel barges.

Marine Terminal Projects

The Federal Government is planning the construction of an iron and concrete dock at Southport, N. C.

Submarine Tender *Bushnell*, of 3,580 Tons Mean Trial Displacement, Recently Completed by the Seattle Construction & Dry Dock Company, Seattle, Wash., for the United States Navy

The Healy-Tibbitts Construction Company, San Francisco, Cal., will build a shed on Pier 35, San Francisco, at a cost of $74,722 (£15,300).

It is reported that Mayor Preston, of Baltimore, favors further improvements on the water front in Baltimore, between Fort McHenry and Ferry Bay, including the construction of eight piers.

The Riverside Contracting Company, New York, has received a contract for extending Pier 22, North River, New York, at a cost of $22,366 (£4,600).

The Torpedo Damage to the Oil Tanker Gulflight

While on a voyage with a cargo of benzine destined for Rouen, the oil tank steamer *Gulflight* was torpedoed by a German submarine near the Scilly Islands on May 1. It so happened that the damage was almost entirely confined to the dry cargo space, and, after being partly submerged for some time, the vessel proceeded to Rouen, delivered the cargo there, and subsequently sailed for the Tyne for repairs.

It may be recalled that the *Gulflight* forms one of the large fleet of the Gulf Refining Company, of New York, and was built in 1914 by the New York Shipbuilding Company, of Camden, N. J. The vessel is a sister ship to the *Gulfcoast, Gulfoil* and *Gulfstream,* built at the same yard for the same owners, and is constructed on the Isherwood system of longitudinal framing. She is 383 feet in length, 51.2 feet in breadth and 30 feet depth. The gross tonnage is 4,591 and the net tonnage 3,202.

Figs. 2 and 3 show the vessel afloat, and Fig. 1 as under repair in the No. 4 dock of Messrs. Smith's Dock Company, Ltd., at North Shields. These illustrations afford an excellent idea of the extent and nature of the damage, which consisted of a large hole on the starboard side, several small holes on the port side, and the damage to the cargo hold forward cofferdam, forward pump room and forward peak. The corrugations show the strength of the longitudinals.

The renewals consisted of 25 new shell plates, 10 removed, straightened and replaced, and all of the transverses and longitudinal frames on the starboard side, and some of those on the port side were renewed, and the center keels renewed in the way of the damage. The deck and beams in the fore hold were entirely renewed, the fore peak and fore cofferdam bulkheads were partly renewed, and the whole of the pump room was also renewed.

The tanks throughout the ship were water-tested and the whole of the piping installation was overhauled and repaired. Although the *Gulflight* was only undocked at North Shields on July 4, the repairs were fully completed and the vessel sailed on August 22 for the Humber and thence for Port Arthur (Texas).

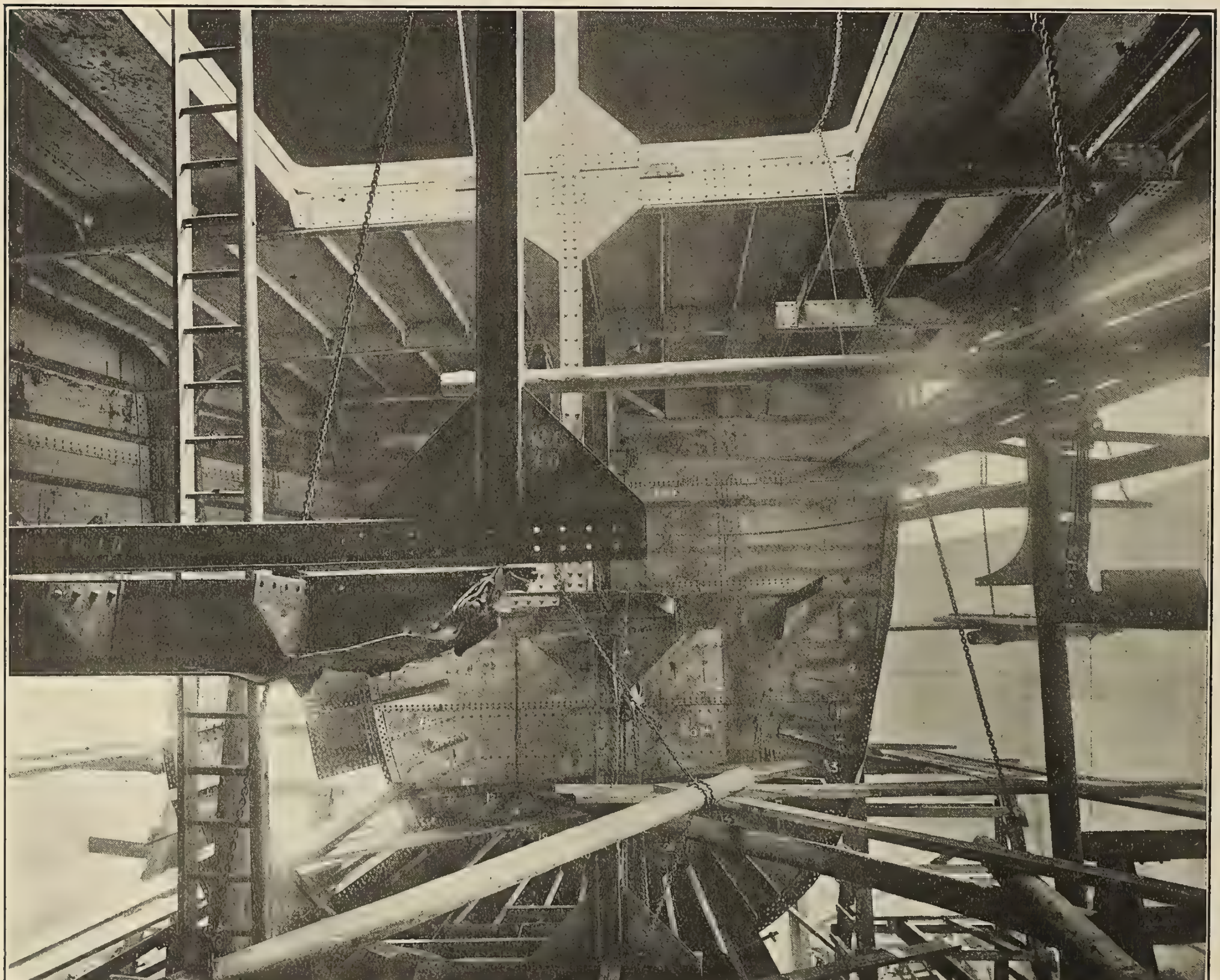


Fig. 1.—View of Forward Hold of *Gulflight* with Damaged Parts Cut Away Previous to Re-construction

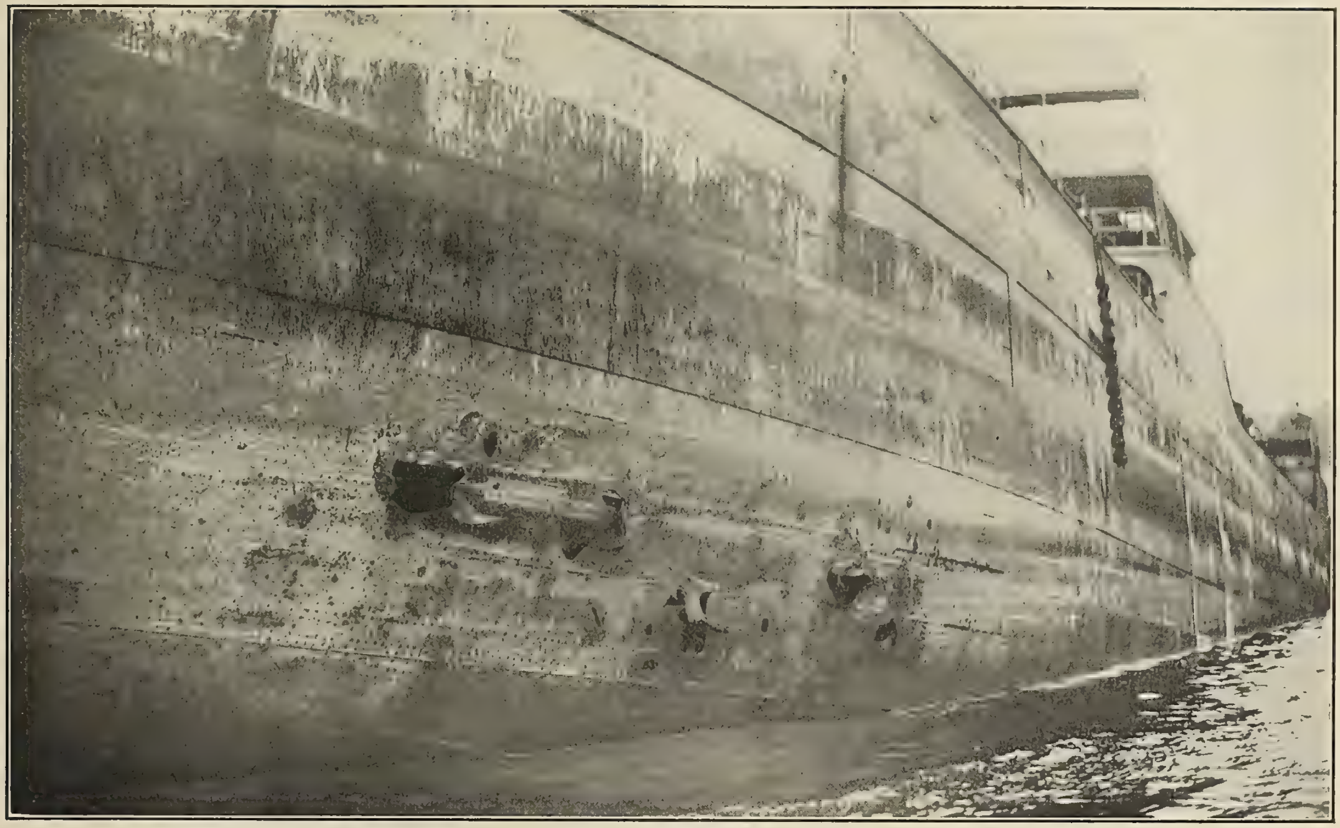


Fig. 2.—Port Side, Showing Holes Made by Force of Explosion from Starboard Side

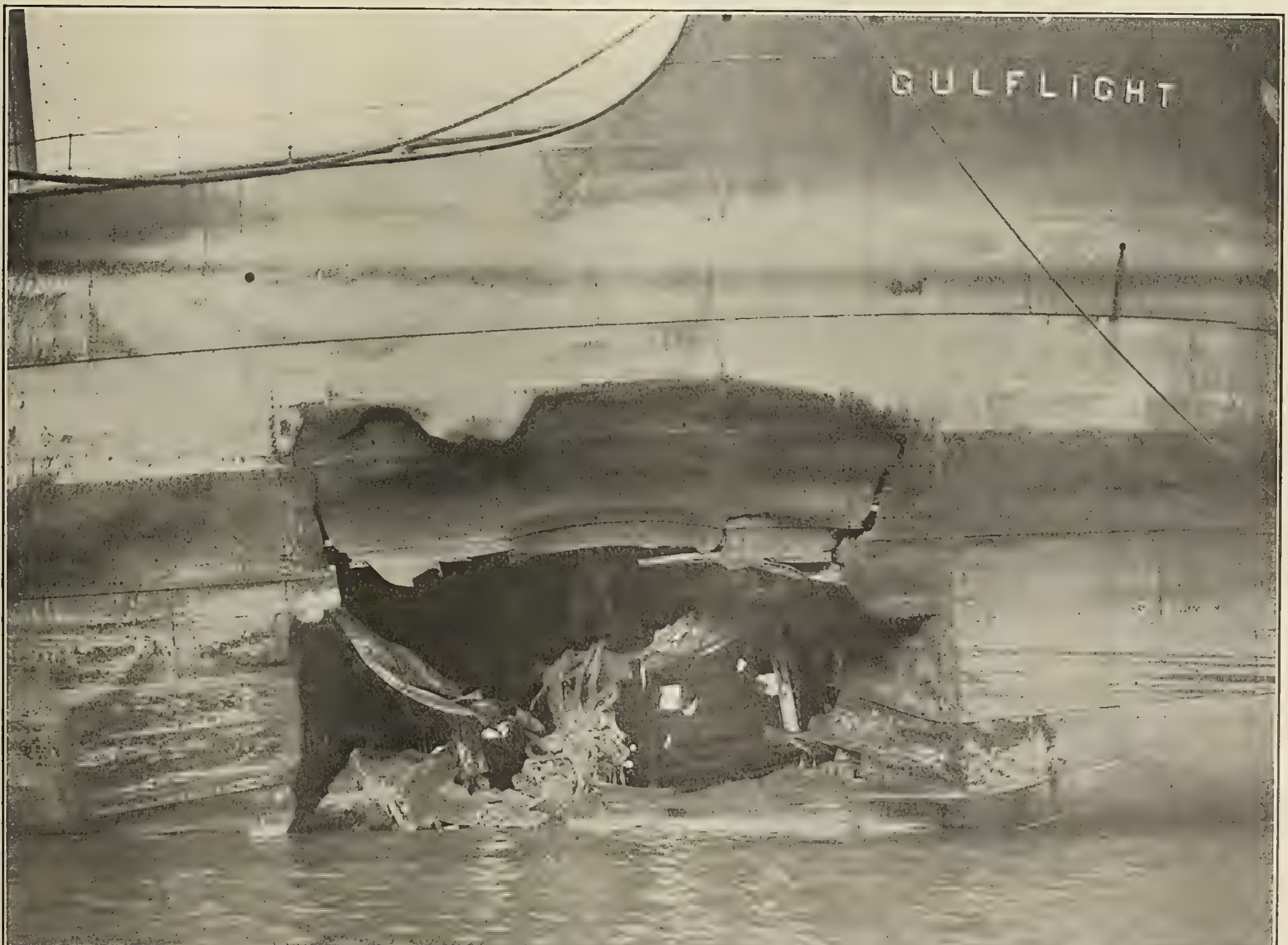


Fig. 3.—Damage to Starboard Side. Corrugations in Plating Show How Longitudinal Framing Resisted Explosive Force of Torpedo

ENGINEERING SPECIALTIES

60 Horsepower Nlseco Diesel Engine

The New London Ship & Engine Company, Groton, Conn., has placed on the market a 60 horsepower Diesel engine of the vertical, single-acting, four-cycle type. Reversing is obtained by means of a heavy duty type of mechanical reverse gear, with friction disks for the ahead motion and spur gears and a band clutch for the astern motion. The thrust is of the roller bearing type. The engine has four working cylinders 7 inches diameter and 9½ inches stroke, and develops 60 horsepower at 450 revolutions per minute. At the after end of the engine there is an air compressor of the two-stage tandem type for supplying air for injecting the fuel and for starting purposes. Provision is made for regulating the pressure carried on the spray air by means of a throttle on the first-stage suction. The weight of the engine complete with flywheel, clutch and thrust bearing is about 8,000 pounds.

The bedplate is in one piece, of cast iron, and is enclosed to catch all oil draining from the bearings. Flanges are provided for bolting to the foundation and for carrying the housing. Cross girders are provided for the main bearings for the crankshaft. The main bearings have cast iron shells lined with white metal, with semicircular lower brasses, so that they may be rolled out after removing the weight of the crankshaft. The bedplate is extended right aft to take the reverse clutch and thrust bearing.

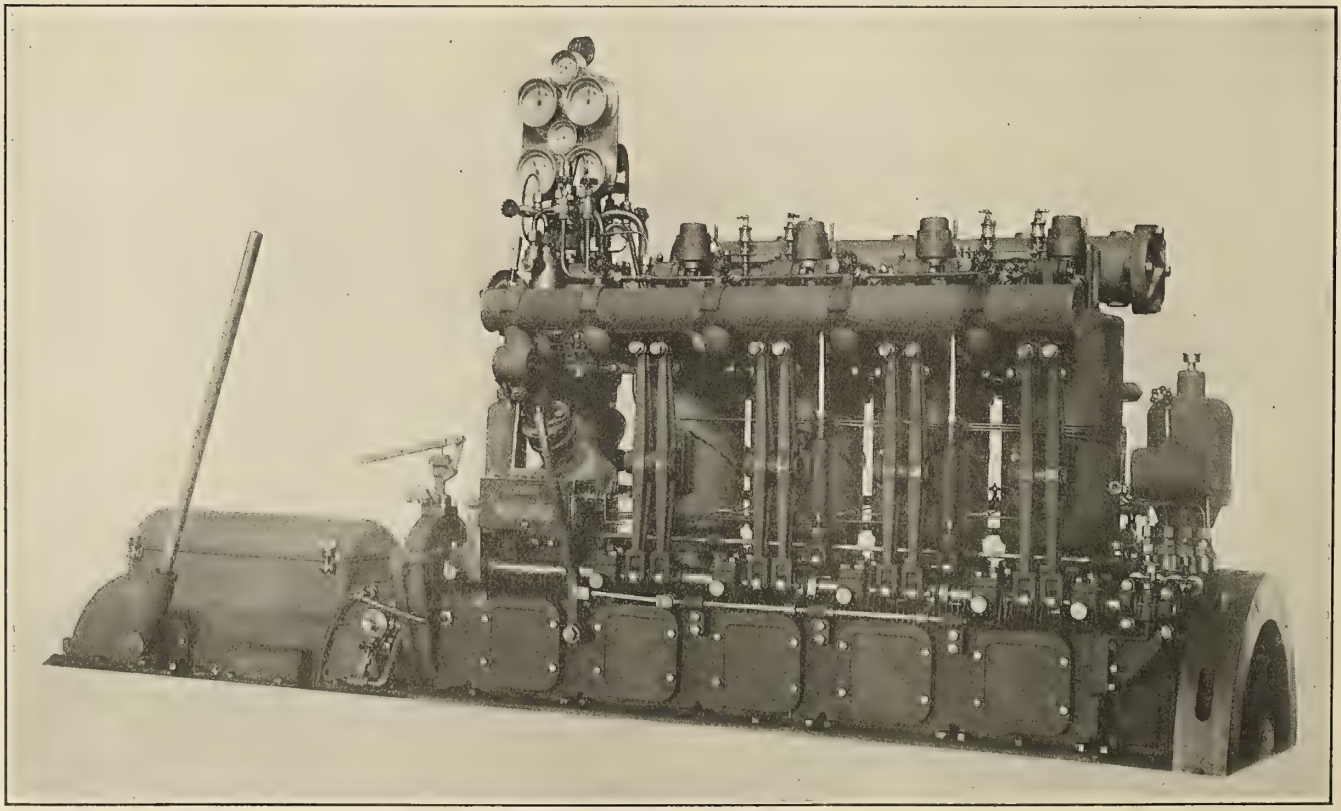
The housing is in one piece of cast iron of rigid design and bolted directly to the bedplate. Large openings with readily removable covers are provided on both sides for access to the crankpit. To the top of the housing are bolted the working and compressor cylinders and the camshaft bearings.

The crankshaft is of forged steel in one piece. The connecting rods are of forged steel with solid wristpin ends fitted with phosphor bronze bushings and tee head crank ends for bolting to the crankpin boxes. The crankpin boxes are of cast steel lined with white metal. The wristpins are steel forgings, hardened and ground and secured in the the pistons.

The working cylinders are of cast iron with water-jacketed barrels and heads. The cylinder heads are cast integral with the barrel and contain all the valves. The pistons are of cast iron of the trunk type and fitted with cast iron snap rings to retain the compression. Each cylinder has an inlet valve and a relief valve on the front of the engine, a spray valve on top and an exhaust valve on the back. The inlet valve is of forged steel and is carried in a separate cage. The exhaust valve has a steel stem with a cast iron head of special design to withstand the action of the hot exhaust gases. The spray valve has a steel needle with atomizer and cage of special design.

The two camshafts, carried in white metal-lined cast iron bearings on the top of the housing, are driven from the crankshaft by means of spur gears on the after end of the engine. The camshaft on the back of the engine operates the exhaust valves by means of rocker levers. The camshaft on the front of the engine operates the inlet valves by means of rocker levers and the spray valves by rocker and bell crank levers. Two of the cylinders are fitted with air starting valves operated from the front camshaft. The operating gear of these valves is so arranged that when they are in operation the spray valves on these cylinders are cut out, and when the spray valves are operating the starting valves are cut out.

The first and second stage air compressor cylinders are in one piece, of cast iron, water-jacketed and with a separate water-jacketed cast iron second stage head. Both the first and second stage valves are of the auto-



60 Horsepower Nlseco Diesel Engine with Mechanical Reverse Gear

matic spring-controlled type with cone seats. The air cooler, placed on top of the compressor, has separate passages for first and second stage air and has sufficient surface to thoroughly cool the air after each stage of the compression. A spray air flask is secured back of the compressor and is connected into the line between the compressor and the spray valves.

Forced lubrication is used for the principal bearings, the oil being supplied under pressure to the main bearings and thence passing through holes drilled in the crankshaft to the crankpins and through the connecting rods to the wristpins. All surplus oil drains back to the crankpit, is filtered and used over again. The crank case is oiltight to prevent leakage of oil outside. The cylinders are supplied from a positive feed mechanical oiler. Camshaft and other bearings are fitted with grease cups. A few, which are subject to very little motion, are oiled by hand.

The flywheel is bolted to a flange on the forward end of the shaft. There is a flange at the after end of the shaft for bolting to the reverse clutch shaft.

An emergency governor driven from the back camshaft is located at the forward end of the engine and controls the engine speed by holding open the fuel pump suction valves.

The fuel system consists of a pump located at the forward end of the engine and driven from the front camshaft extended, with a separate plunger for each cylinder. Fuel is supplied to this pump from a gravity tank, which is divided into two parts with a filter between to prevent foreign matter reaching the fuel pumps. The discharge from each individual fuel pump leads to its respective spray valve. The speed of the engine is controlled by the amount of fuel supplied to the cylinders, which in turn is controlled by the timing of the individual pump suction valves. The cooling water pump is of the rotary type.

The suction header, forming the inlet muffler, runs along the front of the engine and all working cylinders and the compressor cylinder take air through it. The exhaust header, secured to the tops of the cylinders, is of cast iron and water-jacketed.

The engine is started by means of compressed air supplied to the two middle cylinders. The spray and air starting cams for each of these cylinders are in one piece and the cams for both cylinders are under the control of a common lever. With this lever in one position the air starting valves are in operation and in the other the spray valves are in operation. When starting the engine the starting valves are thrown in, the engine jacked over until one of the cylinders is ready for starting air, the starting air is then turned on and the engine responds at once. As soon as ignition is obtained in the end cylinders, the air starting lever is thrown over, cutting out the starting valves and throwing in the fuel valves and the engine is under normal operation on fuel.

Weston Portable Electrodynamometer Instruments

Problems hitherto considered impossible of solution have been solved, it is claimed, in the designing of the various electrodynamometer instruments which have been placed on the market by the Weston Electrical Instrument Company, Newark, N. J. This line of instruments includes portable single and polyphase watt and volt meters for both alternating and direct current circuits, all of which are meters of precision. The instruments are guaranteed by the manufacturers to have an accuracy of one-half of one percent full scale value on either alternating or direct current circuits of any frequency up to 133 cycles per second and any wave form. They can be used on circuits of any commercial frequency even as high as 500 cycles per second with very slight error, due to phase displacement. Double ranges are provided for both current and voltage circuits. All current ranges can be used for 100 percent overload indefinitely, it is claimed, without introducing error. The movable systems of the instruments have an extremely low moment of inertia, and are very effectively damped. Indications are independent of room temperature or the heating effect of current passing through the coils and the instruments are shielded from external magnetic influences.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 1 shows a single-phase and direct current portable electrodynamometer wattmeter, Model 310. The scales, which are 5¼ inches long, are uniform throughout their entire length. Each scale is hand calibrated and is provided with a mirror over which the knife-edge pointer travels. The pointers are equipped with a simple zero setting device. Special wattmeters can be provided for very low power factors, such as core losses in transformers, giving full scale deflection for 20 percent power factor—that is, the scale value in watts is 20 percent of the volt amperes applied. Fig. 2 is a portable polyphase wattmeter, Model 329. The scales of this meter are also uniform throughout. Figs. 3 and 4 show a portable voltmeter, Model No. 341, and portable ammeter, Model 370, respectively. Both are designed for use on direct current and alternating current. Owing to the principle of operation, these instruments cannot be made with scales that are uniform throughout their entire length, but the upper four-fifths portion of the scale is remarkably legible and uniform. These instruments are all inclosed in mahogany boxes of convenient size.

The "Simplate" Valve—Its Construction and Operation

The Chicago Pneumatic Tool Company, Chicago, Ill., has placed on the market a new design of flat plate air compressor valve known as the "Simplate" valve, for which many advantages are claimed. Its chief advantages are that it is simple; that its plates are independent in action; that each plate has its individual springs; that the tension of the spring on the inlet and discharge valves differs according to the density of the air handled; and,

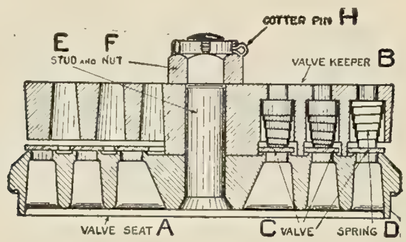


Fig. 1.—Discharge Valve

lastly, that it is applicable to all positions and conditions.

Fig. 1 shows a discharge valve. The valve seat *A*, cast from a special composition, has circular ports. It is machined so that the raised portion of the seat, or the points on which the plates rest, forming the joint, is very narrow, thus reducing the unbalanced area to a minimum. The keeper *B* is of the same material, and is provided with suitable ports for the free passage of air through it. It also furnishes the guides for the valve plates, and affords as well satisfactory pockets for the valve springs. The valves *C* are concentric steel plates of uniform section, with a separate and independent plate over each port. Each

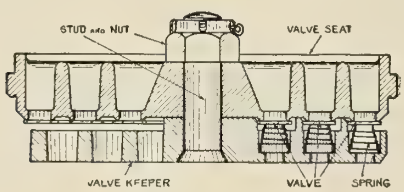


Fig. 2.—Inlet Valve

plate is independently governed by its own springs, hence the action or opening of each valve is entirely independent of the other. Should one of the plates open, the one next to it does not necessarily need to move, unless the speed conditions should demand it. The springs *D* are of the volute type. The parts making up a complete valve are assembled and held together by the nickel steel stud *E* and castle nut *F*, and when this nut is securely tightened in place it is firmly held so by cotter pin *H*.

Fig. 2 shows the inlet valve, the construction of which is very similar to that of the discharge valve. It differs only in the following respects: The valve stud enters through the keeper instead of through the seat, as does the discharge; the keeper is thinner, and the springs are of lighter tension. On account of the difference in the thickness of these valves, they cannot be reversed; that is, the inlet cannot be put in where the discharge should be, nor the discharge where the inlet belongs—a precautionary measure deemed to be highly necessary. The spring tension on the inlet valves is made very light, so as to get the full benefit of the varied opening of the different plates when the piston speed is changed. This illustrates the true meaning of the varied opening.

PERSONAL MENTION

Operating Engineers

W. R. Plant has been appointed assistant engineer of the tug *Sipsey*, New Orleans, La.

E. H. Payne, of New Orleans, La., has been appointed first assistant engineer of the tug *J. W. Morse*.

Daniel Kinsella, of New Orleans, La., has been appointed chief engineer of the tug *Underwriter*.

Eugene Bolander, of New Orleans, La., has been appointed first assistant engineer of the steamer *Parmco*.

James Park, of New Orleans, La., has been appointed first assistant engineer of the steam schooner *Mary Olsen*.

Paul Craver, of Rondout, N. Y., has been appointed chief engineer of the steamer *Marguerite*, stationed at Albany, N. Y.

Henry Gates has been appointed night engineer of the United States Government tug *General Totten*, at North Troy, N. Y.

Samuel J. Ryan, of Glens Falls, N. Y., has been appointed chief engineer of the United States Government tug *Colonel Thayer*.

Ed. Miller, of New Orleans, La., has been appointed second assistant engineer of the steamship *J. D. Archbold*, of the Standard Oil Company.

"Milwaukee" Bill Ryan has been appointed chief engineer of the *William H. Kinch*, of the Great Lakes Dredge & Dock Company, at Albany, N. Y.

Melvin Leap has resigned as chief engineer of the *Val P. Collins* to accept the position as chief repair man for the boats of the Combined Coal Company at Cincinnati, Ohio.

Henry Stammell, formerly chief engineer of the steamer *William H. Kinch*, has been appointed chief engineer of the tug *Lydia* for the Miller Dredging Company, Albany, N. Y.

A. Erickson, of New Orleans, La., formerly of the tug *Underwriter*, has been appointed second assistant engineer of the steamer *Chalmette*, of the Southern Pacific Company.

Sam Wheatland has been appointed acting chief engineer of the large tug *Welcome*, which has been brought from Buffalo, N. Y., to Albany, N. Y., by the Great Lakes Dredge & Dock Company.

Earle Byron has been appointed chief engineer of the passenger steamer *Ohio*, with W. H. Webber as first assistant engineer. The *Ohio* is plying between Cincinnati, Ohio, and Memphis, Tenn.

William Spencer, chief engineer of the steamer *G. V. S. Quackenbush*, of the Troy & Albany excursion line, has accepted a position on the steamer *Mohawk*, of the Manhattan Navigation Company, New York.

A. J. McMillian, formerly of the steamship *Coppername*, of the Fruit Steamship Company, Ltd., has accepted the position of first assistant engineer of the steamer *New Orleans*, of the Merchants & Miners Transportation Company.

E. J. Taylor, of Cincinnati, Ohio, has been appointed chief engineer of the river passenger steamer *Kentucky*, with Richard Simms as first assistant engineer. The

Kentucky runs between Cincinnati, Ohio, and Madison, Ind.

Carlisle Jenkins, of Cincinnati, Ohio, formerly chief engineer of the river steamer *Val P. Collins*, has been appointed chief engineer of the *Catharine Davis*, with Phillip Klipp as first assistant engineer. The *Catharine Davis* is engaged in towing coal for the Island Creek Fuel Company from Huntington, W. Va.

Naval Architects, Consulting Engineers, Draftsmen and Shipyard and Steamship Officials

Peter Doig, formerly connected with the firm of Harland & Wolff, Belfast, is now chief draftsman of the Shanghai Dock & Engineering Company, Shanghai, China.

William M. Kennedy, formerly quarterman ship fitter at the League Island Navy Yard, Philadelphia, Pa., has been appointed foreman of hull construction at the works of the Ellicott Machine Corporation, Baltimore, Md.

W. A. Fairburn, who was connected with shipbuilding several years ago in the drafting room of the Bath Iron Works, and who later had to do with the designing and building of the steamships *Dakota* and *Minnesota* at the yard of the Eastern Shipbuilding Company, Groton, Conn., has been made president of the Diamond Match Company.

George Owen, naval architect of Newton, Mass., and a graduate of the Massachusetts Institute of Technology, has been appointed to fill the vacancy in the faculty of the department of naval architecture of the Massachusetts Institute of Technology, Boston, Mass., caused by the resignation of H. A. Everett, associate professor of naval architecture at the Institute.

Foster Milliken, formerly president of Milliken Bros., Inc., manufacturers of structural steel and iron, has been elected president of the McNab & Harlin Manufacturing Company, New York, a firm which has been engaged during the past sixty years in the manufacture of brass, iron and steel valves, cocks and fittings for steam, water and gas. The main offices of the company are at 55 John street, New York, and its works at Paterson, N. J.

OBITUARY

Sir Thomas Benjamin Bowring, director of T. C. Bowring & Co., ship owners of Liverpool and London, died on October 18 at his home in London, in his sixty-ninth year. Sir Thomas represented his firm as resident partner in New York from 1870 to 1891.

Captain John J. Knapp, U. S. N., commandant of the Philadelphia Navy Yard, died at the Navy Hospital at Philadelphia on September 28 from apoplexy. Captain Knapp was fifty-eight years old.

Captain William F. Evans, senior captain of the Mallory and Clyde Steamship Lines, died recently in San Juan, Porto Rico, aged sixty. At the time of his death Captain Evans was in command of the steamship *Brazos*. He had been employed in the passenger service between Galveston and New York for over thirty years.

John Lloyd, president of the John Lloyd Company, New York, died on October 5 at his home in Brooklyn, aged eighty. During the Civil War, Mr. Lloyd served in the United States Navy as an assistant engineer, and resigned in 1867 with the rank of first assistant engineer.

Merritt David Lawrence, vice-president and treasurer of the firm of Downey & Lawrence, marine railway engineers, Brooklyn, N. Y., died recently at his home in Brooklyn, aged seventy-six.

John E. Dealy, connected with the Robins Dry Dock Company, Brooklyn, N. Y., and a prominent member of the New York Maritime Exchange, died recently at his home in Brooklyn, aged forty-one years.

Paul Gottheil, for many years a member of the shipping firm of Funch, Edye & Co., New York, died at his home in Lawrence, Long Island, on September 22, aged fifty-nine. The firm of which Mr. Gottheil was a member is said to represent more regular steamship lines than any other single firm in North America, their principal agency being that for the Holland-America Line. Mr. Gottheil was also president of the United States Shipping Company, formed in 1896.

Programme of Naval Architects' Meeting

A partial list of the papers to be read at the twenty-third annual meeting of the Society of Naval Architects and Marine Engineers, in New York, on November 18 and 19, is as follows:

"Aerodynamical Experiments upon a Yacht's Mainsail." By Professor H. A. Everett.

"Inland Navigation and Barge Construction vs. Floating Bridges." By J. H. Bernhard.

"The Variation in Frictional Resistance of Ships with Condition of Wetted Surface." By Naval Constructor Wm. McEntee, U. S. N.

"The Determination of the Resistance of Ships." By E. H. Rigg.

"Results of Model Tank Experiments to Determine the Action of a Ship Brake." By Captain Wm. Strother Smith, U. S. N.

"Some Comparisons Relating to Electric Propulsion of a Battleship." By W. L. R. Emmet.

"Interior Decoration of Vessels." By Harry B. Etter.

"Data on Hog and Sag of Merchant Vessels." By T. M. Cornbrooks.

"Period of Vibration of Steam Vessels." By Wm. Gatewood.

"The Application of Small Steam Turbines for Auxiliary Purposes on Board Ship." By W. J. A. London and F. D. Herbert.

"The Maintenance of the Fleet." By Captain A. P. Niblack, U. S. N.

"The Submarine of To-day and To-morrow." By L. Y. Spear.

"Superheated Steam in Marine Practice." By H. B. Oatley.

The meetings will be held in Assembly Room No. 1, Engineering Societies Building, 29 West Thirty-ninth street, beginning at 10 A. M. each day of the meeting.

The Council of the Society will meet in the Engineering Societies Building at 3 P. M. on November 17 and the annual banquet will be held at the Waldorf-Astoria Hotel on Friday evening, November 19.

CORRECTION.—The work of fully equipping the freight and passenger steamer *City of St. Joseph*, of the Graham & Morton Transportation Company, Chicago, Ill., with lifeboats, life rafts and davits supplied by the Welin Marine Equipment Company, Long Island City, N. Y., which was described on page 372 of our August issue, was done by the Manitowoc Shipbuilding & Dry Dock Company, of Manitowoc, Wis.

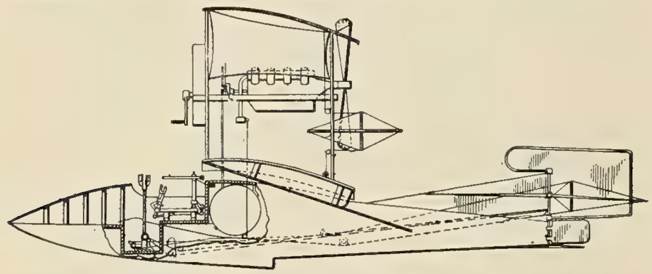
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,142,754. FLYING BOAT. GLENN H. CURTISS, OF HAMMONDSPORT, N. Y.

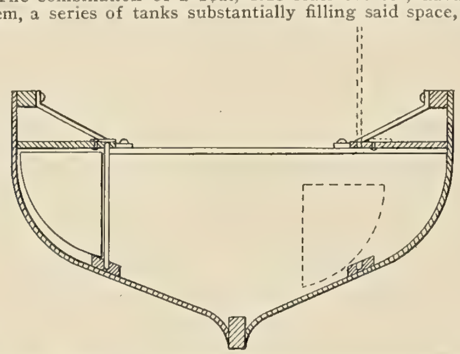
Claim 1.—In a hydro-aero machine, the combination of one or more air plane supporting surfaces extending transversely of the machine in lifting relation thereto, rigid floating means for supporting the machine on the water including a forward buoyant portion having a hydroplane surface commencing at a point well in advance of the center of gravity of the machine and extending downwardly and rearwardly, terminating in a rearwardly facing step in the vicinity of a vertical line through the center of gravity of the machine, and a rear buoyant portion extending well to the rear of the center of gravity of the machine and



constituting a tail portion decidedly lighter per unit of length and of a decidedly less displacement per unit of length when the machine is at rest on the water, than the forward buoyant portion, said rear portion having a bottom surface commencing at the rear of the step and higher than the bottom of said forward hydroplaning surface, whereby the machine may rock about the step and plane on the water at speed with its tail portion decidedly raised above its normal displacement to readily break from the water, the machine when at rest being supported on both bottom surfaces of said forward and rear buoyant portions to give longitudinal stability, and means for driving the machine at such speed as to cause it to rise from the water. Twenty-eight claims.

1,144,434. BOAT. AXEL A. SAWMAN, OF BROOKLYN, N. Y.

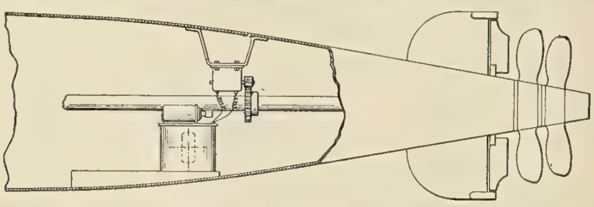
Claim.—The combination of a boat, side seats thereof, having a space beneath them, a series of tanks substantially filling said space, removable



rods adapted to prevent lateral removal of said tanks, and means to lock said rods. One claim.

1,145,025. GYROSCOPIC STEERING DEVICE. FRANK M. LEAVITT, OF SMITHTOWN, N. Y., ASSIGNOR TO E. W. BLISS COMPANY, OF BROOKLYN, N. Y., A CORPORATION OF WEST VIRGINIA.

Claim 1.—The combination with an automobile torpedo of a gyroscope for controlling its steering, a spinning-up mechanism adapted to



spin up the gyroscope to normal speed during the launching operation, and an electro-motor associated with the gyroscope and a generator therefor associated with and controlled by the torpedo driving mechanism, adapted after the torpedo motor has acquired normal speed to keep the gyroscope revolving at normal speed. Four claims.

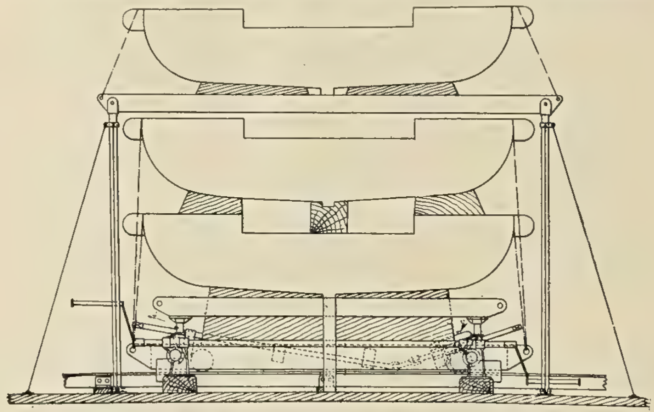
1,133,282.—TORPEDO. GUSTAV P. HELFRICH, OF NEW YORK, N. Y.

Claim 1.—In a torpedo a casing provided with a plurality of compartments, a spool arranged in one of said compartments, said spool being designed to carry a wire, means for supplying current to said wire, means arranged in said casing connected with the wire on said spool for propelling the torpedo, means for supplying a water jet, means for supplying an intermittent light, means for automatically controlling the tossing of the torpedo, and means for turning the torpedo to the right or left, according to the amount of current impressed on the wire on said spool. Nine claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

21,492/1914. MEANS FOR STOWING SHIPS' LIFEBOATS. THE MARTIN PATENT DAVIT COMPANY, LTD., 9, UNION COURT, LIVERPOOL, AND E. S. GLADSTONE.

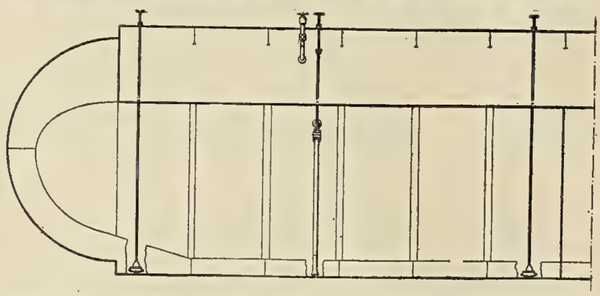
Where lifeboats are stowed in tiers of two, three or more boats one above the other it is in some cases considered desirable that the upper boat or boats should not rest directly on the boat or boats beneath, but should be separately supported. According to the invention the supports are so constructed that a complete tier of boats can be deposited on a carriage and moved away clear of the supports. An intermediate



boat is supported on the lowest boat and the top boat is carried by cross beams supported by uprights hinged to the deck and supported by guys. A platform is carried by lifting means and adapted to lower the tier of boats on to the carriage. When it is desired to move the boats in the side of the ship the platform is raised until the intermediate boat comes against the cross beams, the supports are then disconnected from the cross beams and turned down on their hinges so that the lowest boat supports the weight of the intermediate and top boats; the platform is then lowered until the lowest boat settles down on the carriage, which can then be moved away as desired.

14,762/1914. MARINE STORAGE TANKS FOR OIL. W. DOXFORD, PALLION SHIPYARD, SUNDERLAND, AND C. P. M. JACK, 32 GREAT ST. HELENS, LONDON.

Claim.—This invention relates to marine storage tanks for oil, of the kind so constructed that when loaded with oil they will either float, or be completely submerged lying on the bottom, or will float with one end on the bottom, or will lie on the bottom partly submerged. To this end there are pipe connections arranged in such a manner that the oil storage compartment is always full, either of water, or of oil, or of



oil and water together, in the case of a craft that is intended to be entirely submerged. Thus the external head is balanced or nearly so, and the loads on the structure are very small so that within practical limits a very much larger cylinder or tank can be built than would be otherwise permissible. The oil is withdrawn from the oil compartment by an oil-section pipe at the highest level therein (e. g., it might be buoyed therein), and when oil is pumped out through this pipe, water flows in automatically through another pipe whose mouth may be on the exterior of the oil compartment above the bottom, but whose inner mouth opens into the interior of the oil compartment at the bottom.

6,318/1914. IMPROVEMENTS IN OR RELATING TO SAFETY DEVICES FOR SUBMARINE OR SUBMERSIBLE BOATS. SWAN, HUNTER & WIGHAM RICHARDSON, LTD., AND E. L. PEACOCK, OF WALLSEND SHIPYARD, WALLSEND-ON-TYNE.

According to this invention one or more of all dividing rudders, or planes, for controlling the depth are provided with other means which are adapted to cause said depth controlling means to act in a direction to stop the submergence and if desired to bring the boat to the surface, when the depth controlling means cease to be controllable, or when the boat reaches a certain predetermined depth.

11,834/1914. TORPEDO DIRECTORS. SIR W. G. ARMSTRONG, WHITWORTH & CO., LTD., AND W. H. WADDINGHAM, ELSWICK WORKS, NEWCASTLE-UPON-TYNE.

Claim.—According to this invention the instrument can be used for two or more tubes which are not parallel so that several tubes can be fired from the same control position without too much space being occupied by the employment of a separate director for each tube. To the director arm is connected a telescope or other sight so that it can be moved independently of the arm to follow the target and means are provided for automatically discharging the torpedo when the line of sight coincides with the line of the director arm. There are also provided means for correcting the angle setting of the torpedo gyroscope and also for the distance between the instrument and the torpedo tube.

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Cause of Loss of the F-4

From facts established by the investigation of the board of naval officers appointed to determine the cause of the loss of the United States submarine *F*-4, which was sunk outside of Honolulu harbor on March 25, it has been concluded that the primary cause of this disaster was the corroded condition of the lead lining, and of certain rivets, in the port wall of the forward steel battery tank. Apparently unknown to the commanding officer, the vessel acquired some negative buoyancy forward of the center of gravity through the leaky rivets in the wall of the battery tank, causing the boat to dive. Secondary causes of the disaster were laid to the poor diving qualities of the vessel and the consequent failure of the boat to respond promptly to measures taken to bring her to the surface. Accepting corrosion as the primary cause of the disaster, it apparently indicates a lack of care and inspection of the vessel. The likelihood of corrosion is always present in all vessels and machinery, and the only sure prevention of this is regular and minute inspection, with thorough cleaning and overhaul.

Hog and Sag of Merchant Vessels

Considerable data have been brought out at recent meetings of the Society of Naval Architects and Marine Engineers regarding the sagging and hogging of various types of merchant and naval vessels. The change of shape of single-deck vessels as affected by the distribution of loads in the structure of the vessel seem to have been measured with considerable exactness. Much of the data has been taken from government colliers, while the vessels were on the stocks, immediately after launching, when the machinery was installed, when in dock, before loading and when fully loaded. When fully loaded these vessels invariably sagged by amounts varying from 2 to nearly 4 inches, the difference in the amount of sag in different vessels being accounted for by the unequal distribution of the cargo. While the sagging of long single-deck cargo-carrying vessels is properly accounted for by the distribution of the load, the reverse effect of the hogging of the vessel, due to the differences in temperature between the upper part of the vessel exposed to the warm air and the bottom of the vessel exposed to the cold water, does not seem to have been determined with the same exactness. Extreme cases of this are reported on the Great Lakes, where the long single-deck cargo vessels, after being loaded to the proper draft at the beginning of a voyage, have been found to hog to such an extent during the voyage that the draft at the bow and stern has been increased by nearly 6 inches, making it impossible for the vessel to enter the canal locks without lightening the load. This difficulty, however, has been overcome in a thoroughly practical manner by playing hose on the deck of the vessel for some time when approaching the canal locks, the result being that the deck, having been heated by exposure to the sun, is cooled and the vessel straightens itself out, coming back to the draft at which she was originally loaded.

Bids for New Battleships

The bids for the United States battleships Nos. 43 and 44, which were opened by the Navy Department on November 17, have caused much discussion on account of the fact that all of the bids submitted by private shipyards were higher than any estimates submitted by government navy yards. As we have pointed out before, it is practically impossible to reconcile bids of the private shipbuilders and the estimates from government navy yards on account of certain factors which are included in one case and which are practically ignored in the other. The result in this case has been that preparations are now being made, not only to build these two battleships in navy yards, but also to bring about the equipment of as many navy yards as Congress can be induced to provide for, so that a large proportion of the vessels to be authorized by the next Congress can be constructed by the government. In submitting their bids, the private shipbuilders incorporated certain stipulations which in all fairness should be granted by the government. These stipulations proposed that the government should waive certain requirements in contracts heretofore executed, or should stand the expense of certain equipments and incidentals heretofore paid for by the contractors. These items include the contractors' bond, insurance of the vessel during construction, the cost of preliminary trials, and changes in constructional features made after the signing of the contracts. All of these items have had an important bearing on the relative costs of construction in private yards and in government navy yards. To secure a just comparison of the bids, these stipulations should be carefully considered. If they were

granted, the preliminary trials of naval vessels, which were paid for heretofore by the contractors, would be eliminated and the speed of the vessels would be determined on the basis of their performance after six months' test.

Final Report of the Bulkhead Committee

One of the most important services to the shipbuilding industry that has been undertaken in recent years has just been completed by the publication of the second and final report of the Departmental Committee on Bulkheads and Watertight Compartments. This report deals with the subdivision of channel, coasting and river steamers and supplements the committee's first report, issued in January, which covered seagoing vessels. So far as the underlying principles are concerned regarding floodable lengths of the ships and the method of finding the permissible length of compartment by multiplying the floodable length by a factor of subdivision, the same methods are applied in both cases, with exceptions, of course, for various classes of vessel covered in the second report. The fundamental principle upon which these recommendations are based involves the use of cross curves and other data by means of which in ordinary cases flooding curves for any permeability can be obtained for a vessel of given block coefficient, longitudinal distribution of displacement, freeboard and sheer ratios. By multiplying the ordinate of the flooding curve at any point in the length of the ship by the factor of subdivision recommended for the particular length and type of ship the maximum permissible length is found which a watertight compartment can have whose center of longitudinal section is at this point.

The various classes of vessels covered by the second report are grouped in five general classes as follows: passenger steamers plying within home trade limits, passenger steamers plying on short excursions along the coast during daylight and in fine weather between April 1 and October 31, passenger steamers plying within partially smooth-water limits, passenger steamers plying in smooth waters either in estuaries and lakes or on rivers and canals, and cargo steamers, either foreign-going or home trade. As these classes cannot be clearly defined on account of the variations in sizes and services for particular vessels, exceptions to the general recommendations must necessarily be recognized, and undoubtedly the requirements of exceptional vessels will be carefully considered without unduly hampering the shipowners and builders.

An important provision in the line of safety is made as regards the requirements for pumping machinery. In vessels under 250 feet long, in addition to the ordinary bilge pumps on the main engine, or the equivalent engine-room pump, one bilge pump independent of the main engine must be provided, and also one other pump of the Downton or cranked type. In vessels between 250 and under 300 feet an additional Downton or cranked pump must be carried. In vessels 300 feet long and over, two power bilge pumps independent of the main engines must be installed. The piping must be arranged so that each of these extra pumps can draw water from all of the compartments at the rate of 400 feet per minute. Where two extra power pumps are required the source of power for one of them should be independent of the main propelling plant and situated above the bulkhead deck.

Lloyd's Annual Report

In spite of the losses to merchant shipping since the present war began, the business of Lloyd's Register of Shipping does not seem to have been adversely affected. On the other hand, in its annual report for the year ending June 30, 1915, the tonnage of vessels classed by the society during the year is shown to have been 300,000 tons in excess of that classed during the previous year. The vessels actually completed during the year numbered 571 of 1,295,623 tons, of which about 67 percent was built for the British Empire and about 33 percent for other countries. This favorable showing is explained by the fact that while merchant shipbuilding in all the belligerent countries, and especially in the United Kingdom, has necessarily fallen off on account of the great demands for naval construction, nevertheless the lessened production of merchant vessels in those countries has given an impetus to the industry elsewhere. In other words, the actual volume of tonnage which is in hand throughout the world is not materially different from what it was a year ago, but it is distributed in different proportions among the several shipbuilding countries, a large share of the work going to the United States.

Only seven vessels of over 10,000 tons were classed by Lloyd's during the year, the two largest being the *Orbita* of 15,678 tons for the Pacific Steam Navigation Company and the *Transylvania* of 14,315 tons for the Anchor Line. Among the special structural features in vessels built or building during the year, mention is made of two steamers of the *Monitor* type, in which the side plating is worked in a corrugated form, and also of a new form of watertight bulkhead in which the necessary strength and stiffness are obtained by working the plating in a corrugated form. The Isherwood system of longitudinal framing continues to be used extensively. In all, over 300 vessels with this type of framing, totaling 1,675,000 gross tons, have so far been built. As a consequence of the increasing demand for vessels carrying oil in bulk, which has been intensified since the beginning of the war, several ordinary cargo vessels of various types have been converted into tank steamers. In some cases this has been accomplished by placing circular tanks in the holds of ordinary cargo steamers.

In the year's progress in the development of propelling machinery for merchant vessels, the steadily increasing use of steam turbines is noticeable, especially in connection with reduction gearing. Several large vessels were built during the year in which geared turbine machinery was installed. As compared with an all-turbine installation, however, attention is directed to the advantage pos-

sessed by combination reciprocating and turbine machinery, in that the machinery can be worked at reduced speed with practically the same efficiency as at full power, because the supply of steam to the engine can be reduced in quantity by "linking up" without at the same time reducing the pressure. On the other hand, with ordinary steam turbines, which always present the same area of opening for the admission of steam, the quantity of steam entering the engine can be reduced only by reducing the pressure. Two vessels are being built in the United States, however, in which Curtis turbines are to be installed, in which the admission of the high-pressure steam does not take place around the whole of the circumference, but the area of opening can be varied between certain limits to regulate the steam supply.

There is also another special feature in which these turbines differ from other installations. In order to obtain reasonable efficiency in the steam turbine the peripheral velocity of the blades must bear a certain proportion to the velocity of the steam flowing past them. This velocity is determined by the difference of pressure on the two sides of the various rows of blades. Where many rows of blades are arranged the fall of pressure on each row is less than where fewer rows are employed, consequently the velocity of the steam is also less where many rows of blades are used, and therefore lower speeds of the engine are admissible. In the Curtis turbine comparatively few rows of blades are used. The drop of pressure past each row is large and, consequently, the velocity of the steam past the blades is high. This necessitates a very high speed of rotation and, in the installations referred to, the turbine speed at full power will be above 3,500 revolutions per minute. This high speed will be reduced to about 90 revolutions per minute at the propeller shaft by means of a double set of gearing. The turbine shaft is coupled to a pinion with helical teeth, which gears into two wheels, each on separate shafts, which turn at about 700 revolutions per minute, each of these shafts transmitting one-half of the power. The pinions on these shafts, in turn, gear into a double steel wheel on the main propeller shaft, causing a further reduction of speed to about 90 revolutions per minute. This arrangement provides for a certain amount of flexibility and elasticity by means of spherical seated bearings for the gear shafts. The extremely high speed of rotation of the turbine and the small number of rows of blades permit this part of the propelling machinery being made much lighter than would be the case with corresponding parts in an ordinary steam turbine of the same power for direct drive.

Although progress in the commercial development of the Diesel engine for marine work has been seriously retarded by the war, nevertheless during the past year several new vessels have been fitted with Diesel engines, and at present Lloyd's has classed 38 ships fitted with this type of machinery. Of these, the East Asiatic Company, of Copenhagen, owns ten, the Nederlandsch-Indische Tankstoomboot Maatschappij eight, and the Rederi Aktiebolaget Nordstjernan six. Thirteen of these vessels were built and engined by Burmeister & Wain, of Copenhagen, and eleven were engined by the Werkspoor Company, of Amsterdam. A two-stroke cycle Diesel engine, in which the cylinder contains two pistons, operating in opposite directions, has been developed by Messrs. W. Doxford & Sons, Ltd., with apparently satisfactory results. In this engine the effective stroke is the sum of the strokes of both pistons and the total height required for the engine is less in proportion to the length of the stroke than that of any other type. This type of engine is especially suitable for cases where the height is restricted and where long strokes are desired in order to obtain a reasonably high piston speed without an undue number of revolutions.

Preparedness for Defense

At a recent meeting of the New York Commandery of the Society of American Wars, attended by officers of the United States army and navy, a committee was appointed to secure the co-operation of all other patriotic societies and kindred organizations of the United States for a united demand for such legislation by Congress as will provide ample and adequate means of national defense both on land and sea. It goes without saying that this demand is made not with any idea of so-called "militarism" or the acquisition of new territory by force of arms, but for the purpose of guaranteeing the citizens of the United States the security and governmental protection which by its strength will discourage any plan of invasion by a foreign nation, and which at the same time will be the best guarantee of peace in the future.

This movement, as well as all others which tend to arouse the people of the nation and in turn their representatives in Congress to a full appreciation of the vital need of more adequate preparedness for defense, deserves unqualified support. For the adequate defense of a country situated like the United States, however, there can be no question as to the importance above everything else of a strong and efficient navy, rather than a big army. The interests of the United States are not centered within its own boundaries. They extend to every part of the world, and to secure the rights of American citizens on the high seas and in foreign countries no force is more potent than a strong and efficient navy. Few will now dispute the fact that if the United States had had a dozen more battleships at the time of its differences with Spain, eighteen years ago, there would have been no so-called Spanish-American War, and that the cost of those battleships would have been only a small fraction of the cost of the war. To profit by such a costly lesson, the first demand of the citizens of the United States for better protection should be for increased naval strength—and by increased naval strength we mean not only a bigger and more powerful navy, but adequate reserves of men, munitions and supplies and the enrollment of engineers, naval architects, shipbuilders and all men who, by training, skill and experience, can contribute to the upbuilding and maintenance of the navy in cases of emergency.

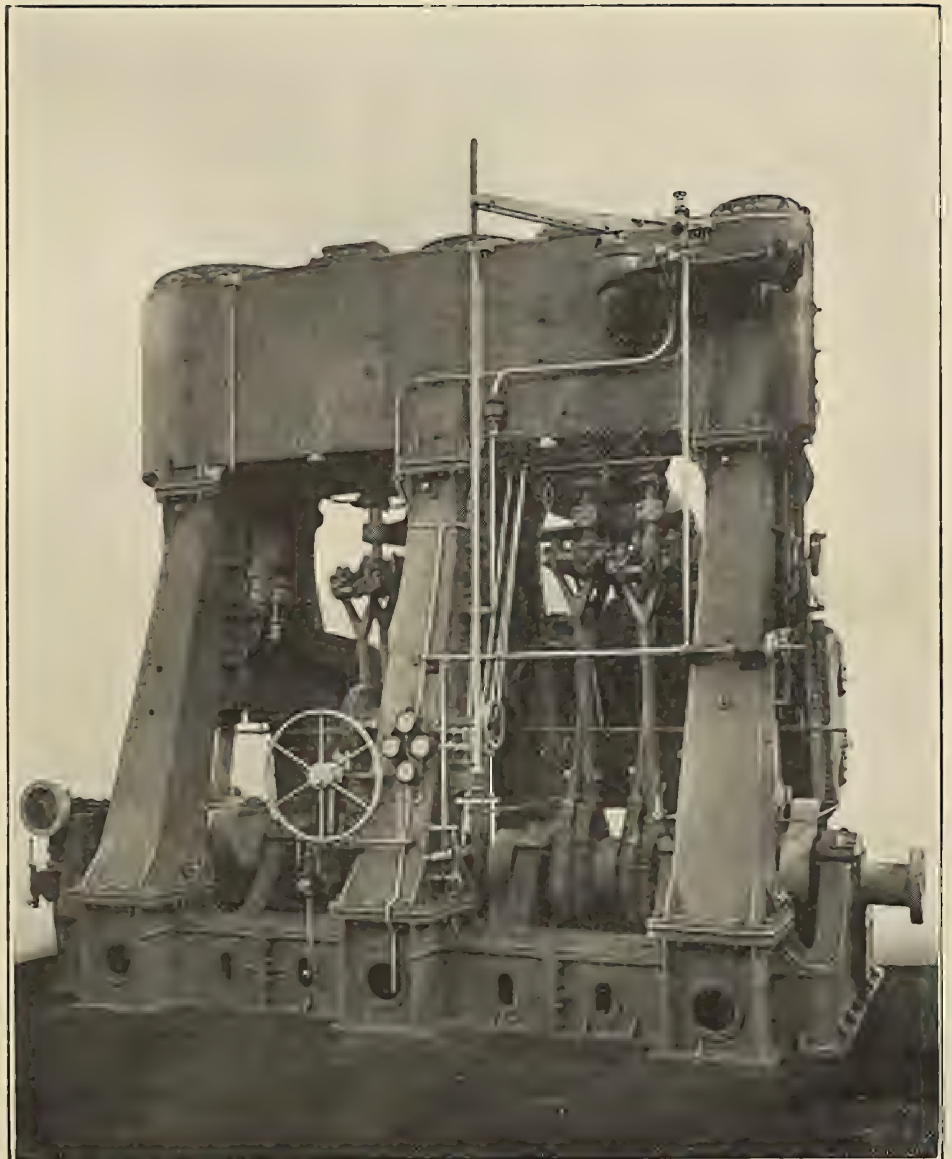


Fig. 1.—Front View

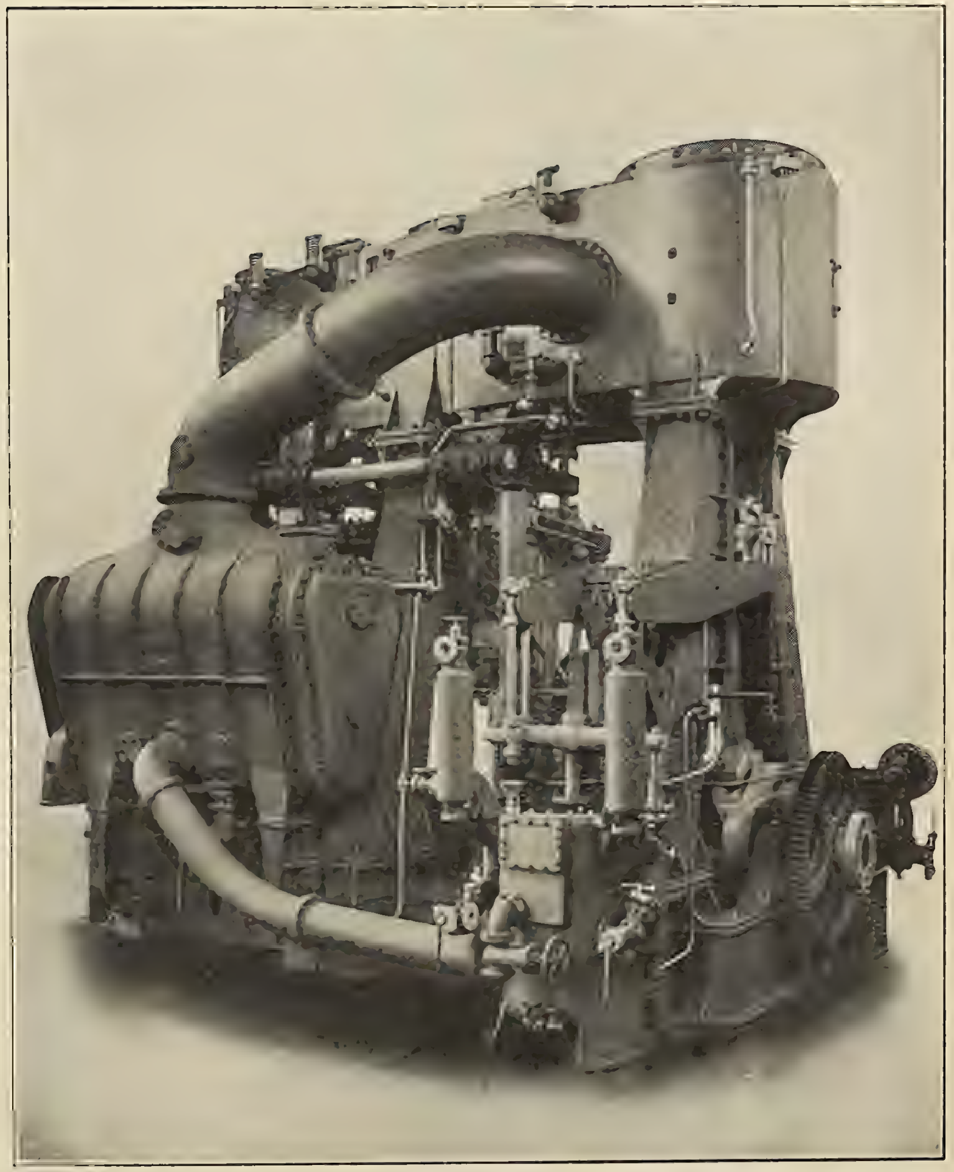


Fig. 2.—Back View

Triple Expansion Engine of 2250 indicated horsepower, built by Messrs. Richardsons, Westgarth & Co., Ltd., of Hartlepool for the steamship *Northwestern Miller*. The cylinder diameters are 29, 49 and 80 inches and the stroke 54 inches

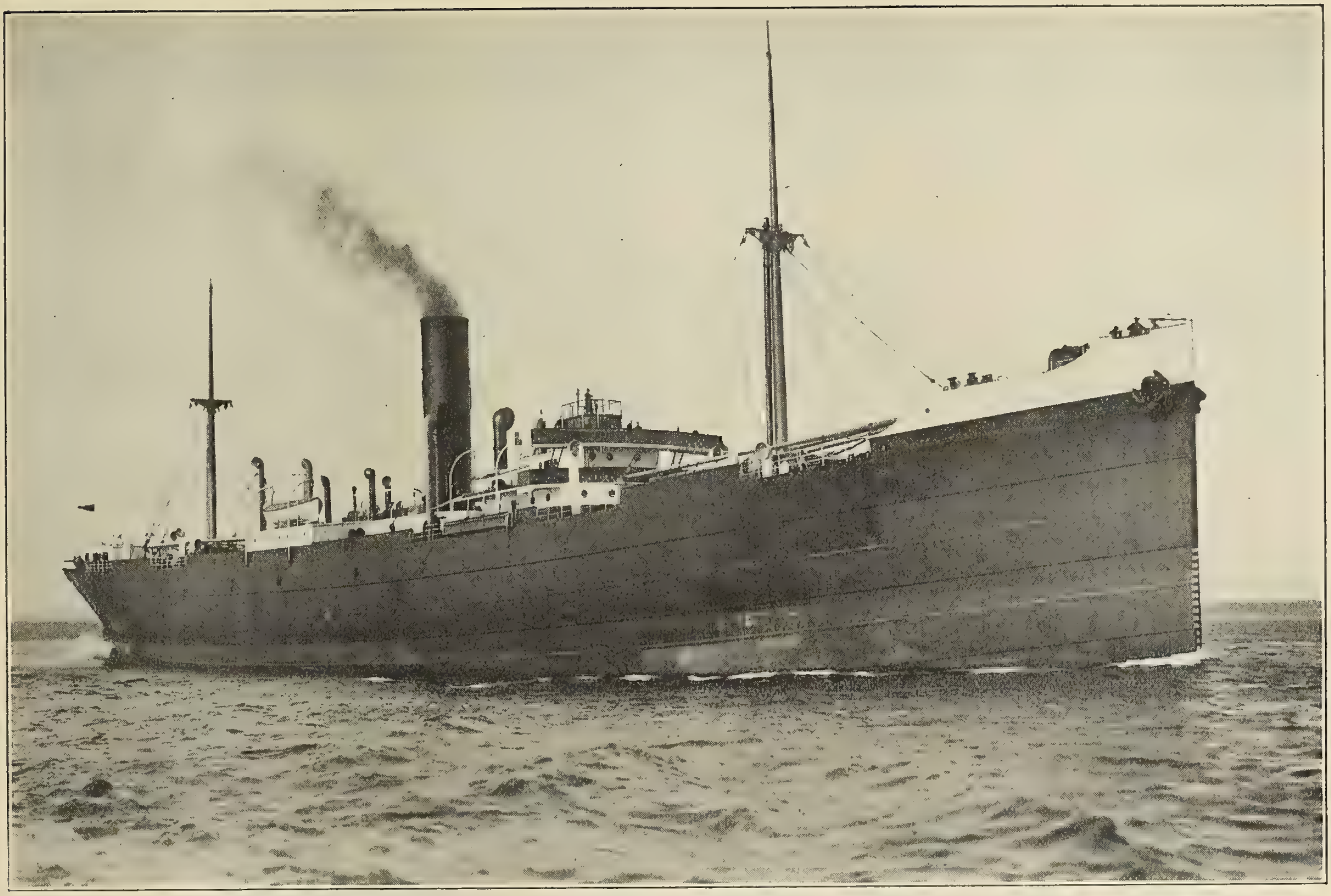


Fig. 3.—Steamship *Northwestern Miller*: Length, 433 Feet 6 Inches; Beam, 53 Feet 6 Inches; Depth, Molded, 39 Feet

New Steamers for American Flour Trade

Built by the Northumberland Shipbuilding Company, Ltd., Howdon-on-Tyne, and Engined by Messrs. Richardsons, Westgarth & Company, Ltd., of Hartlepool, for the Philadelphia Transatlantic Line

BY FREDERICK C. COLEMAN

Two steamers, specially designed for the conveyance of flour, were ordered in England last year from the Northumberland Shipbuilding Company, Ltd., of Howdon-on-Tyne, by Messrs. Furness, Withy & Co., Ltd. These vessels, named the *Northwestern Miller* and *Southwestern Miller,* have recently entered the North Atlantic trade in the service of the Philadelphia Transatlantic Line, between London and Philadelphia. They are of uniform design and dimensions, and each takes the highest class at Lloyds, 100 A1. The following are the principal dimensions:

Length overall	433 feet 6 inches
Length between perpendiculars	420 feet
Breadth, extreme	53 feet 6 inches
Depth, molded, to shelter deck	39 feet
Shelter 'tween decks	8 feet 6 inches
Main 'tween decks	8 feet 6 inches
Draft, laden	26 feet 9 inches
Draft in ballast and bunkers	16 feet 6 inches
Deadweight, including bunkers	8,600 tons
Coefficient	·73

The vessels are built on the three-deck principle, including a shelter deck with deep frames of heavy bulb angle section.

The decks are carried on heavy tandem girders and wide-spaced, built-up pillars, thus keeping the holds and 'tween decks exceptionally clear for the convenient stowage of large and bulky cargoes. An orlop deck extends the full length of No. 1 hold and is suitable for carrying special cargo.

There are seven steel watertight bulkheads and a cellular double bottom extends fore and aft for water ballast, and water ballast is carried in a deep tank built aft of the engine-room bulkhead and in fore- and after-peak tanks, as shown in the table given below.

The vessels are schooner rigged, the fore and main masts being built specially strong to deal with 25-ton lifts. There are four derrick posts to handle cargo in the deep tank and No. 3 hatch, and a total of sixteen derricks, one of which, fitted at the after side of the fore mast, is capable of dealing with 25-ton lifts at No. 2 hatch. There are six cargo hatches, four of which are 26 feet 6 inches by 18 feet, one 13 feet 3 inches by 18 feet, and another 15 feet 5 inches by 18 feet. Grain divisions and shifting boards are supplied in Nos. 2, 3 and 4 holds.

The deck machinery includes eleven 7-inch by 12-inch steam winches, fitted with large barrels and whipping and warping drums, and these were supplied by Messrs. Clarke,

Chapman & Co., Ltd., and there is also a quick-warping steam windlass, which was supplied by Messrs. Emerson, Walker & Co., Ltd. The steam steering gear is of the Wilson-Pirrie type, controlled by Brown's telemotor gear, amidships, and there is also hand gear. There is a Kelvin patent standard compass and sounding machine.

The following are tables of the various capacities:

Shelter 'Tween Decks

	Grain	Bales
Forward shelter 'tween decks	64,000	57,600
After shelter 'tween decks	57,150	51,500
Casing side	15,550	14,000
Cabin store	3,700	3,500
Forecastle	5,040	4,530
Fore-peak stores	6,900	2,620
Tonnage well	1,480	1,350
After peak	4,330	......
Total capacity	158,150	135,100

Main 'Tween Decks

	Grain	Bales
No. 1 'tween decks	20,900	19,000
No. 2 'tween decks	39,700	36,200
No. 3 'tween decks	15,900	14,500
No. 4 'tween decks	20,900	19,000
No. 5 'tween decks	18,800	17,100
Total	116,200	105,800

Holds

	Grain	Bales
No. 1 hold, upper	29,900	27,500
No. 1 hold, lower	20,750	19,100
No. 2 hold	98,200	91,400
Deep tank	32,700	30,600
No. 3 hold	49,100	45,200
No. 4 hold	33,500	30,500
Total capacity	264,150	244,300

Bunkers

	Tons
Engine and boiler room, port side	112
Engine and boiler room, starboard side	135
Total in engine and boiler space	247
'Tween decks (port side)	118
'Tween decks (starboard side)	136
Shelter 'tween decks (port and starboard sides)	320
Coal shoot	29
Total bunker capacity	850

Water Ballast

	Tons
No. 1 tank	135
No. 2 tank	490
Dry tank (74 tons)	
No. 3 tank	155
No. 4 tank	350
No. 5 tank	100
Deep tank	955
After-peak tank	125
Fore-peak tank	110
Total capacity	2,420

The accommodation throughout is fitted with steam heating, and the ventilation of the lower holds and 'tween decks was specially considered, four ventilators being fitted to each hold and 'tween decks. The electric lighting installation comprises twelve large cargo clusters, mast head, side and stern lights. The anchors are of Byers' patent stockless type.

A large dining room for the captain and officers is situated amidships on the shelter deck, and the captain, chief officer and Marconi wireless operator are berthed in a large steel deckhouse on the top of the saloon house. The officers, engineers and apprentices are berthed in steel deck houses at the side of the vessel on the shelter deck, abreast of the engine room casings, while the crew are accommodated aft under the shelter deck, and have cubicles for the separate watches. The mess room is fitted in the center alleyway. The petty officers' quarters, hospital, wash house and toilet rooms are on the large steel deck house aft on the shelter deck.

The propelling machinery of each of these vessels, supplied and fitted by Messrs. Richardsons, Westgarth & Co., Ltd., of Hartlepool, consists of a set of powerful triple-expansion engines, specially designed for the heavy North Atlantic trade. The bearing surfaces are exceptionally large, and the scantlings throughout are of very ample proportions. The cylinders are 29 inches, 49 inches and 80 inches diameter by 54-inch stroke. The indicated horsepower is 3,250 and the nominal horsepower 681.

Steam is supplied by three large single-ended boilers, 17 feet 6 inches diameter by 12 feet length, each working at a pressure of 180 pounds per square inch and having four furnaces and arranged for Howden's system of forced draft. The heating surface is 10,450 square feet.

Both main and auxiliary condensers are of the Contraflo type, this system being adopted in its entirety, with compensator exhaust steam surface feed heater and Cascade filter. The propeller shaft is forged of "lockfast" iron, fitted with continuous gun-metal liner, and the propeller is of solid manganese bronze.

The large number of auxiliaries in the engine room include centrifugal circulating pump with enclosed engine, independent, slow-speed feed pumps, extra large ballast pump, auxiliary feed pump, and a Morison's evaporator.

The machinery was built to pass the Board of Trade and Lloyds requirements, and to the inspection of Messrs. Esplen & Sons, Ltd., of Liverpool. These two vessels have a service speed of about 13 knots.

First Diesel-Engined Vessel for the United States Navy

The U. S. S. *Maumee* is one of two twin-screw fuel ships authorized by the Naval Appropriation Act of August 22, 1912, "to cost, exclusive of armor and armament, not to exceed one million, one hundred and forty thousand dollars (£234,000) each, and which shall be built in navy yards, one to be built in a navy yard on the Pacific Coast." These two vessels, the *Maumee* and her sister ship, the *Kanawha*, were built in the Mare Island Navy Yard to carry fuel and minor supplies for the fleet.

The *Kanawha*, now in commission with a merchant complement, is propelled by two triple-expansion steam engines of 2,600 indicated horsepower each, while the *Maumee* is to have for propelling machinery two Diesel engines of 2,500 brake horsepower each. At the time these vessels were authorized there were already afloat a number of motor ships whose performance warranted the adoption in our service of Diesel motors of the heavy, slow-speed type for our auxiliary vessels. The sum of

money available for the construction of the *Maumee* was based on steam-engine propulsion, and was not sufficient to cover the entire cost of experimental and construction work of a pair of large Diesel engines.

In order to introduce this type of motive power into our service, a Naval Appropriation Act of March 4, 1913, provided "that the unobligated balances under the appropriation 'Steam Machinery' for the fiscal years ending June thirtieth, nineteen hundred and twelve, and June thirtieth, nineteen hundred and thirteen, not exceeding $250,000 (£51,250) are hereby reappropriated and made available for the development of a type of heavy-oil engine suitable for use in one of the fuel ships authorized by the act approved August twenty-second, nineteen hundred and twelve, and the expenditure thus incurred shall not be a charge against the limit of cost of such vessel."

It is the present intention of the Navy Department to man the *Maumee* with officers of the navy and an enlisted crew.

The two ships are similar except as to their propelling machinery, which, however, will be kept within the same machinery spaces on both vessels; that is, between frames 136 and 166. Externally their appearance will be the same, except that the smokestack of the *Maumee* will come out of the after end of the machinery spaces, while that on the *Kanawha* will come out of the forward part of the machinery spaces. The *Kanawha* has four Babcock & Wilcox boilers forward of the main engines, while the *Maumee* will have two boilers of the same make, but smaller in size, just abaft the main engines.

These two vessels will afford an excellent opportunity of comparing the two types of machinery, as they are not only sister ships, but they will be employed on identically the same duty, and will probably burn the same grade of fuel. It would be premature at this writing to attempt any comparison between the two vessels, except that the *Maumee's* propelling plant will be more costly and considerably heavier that that of the *Kanawha*. A comparison of weights, however, should also include the fuel to cruise considerable distances, in which latter case the question of weight will be in favor of the *Maumee's* plant, owing to the unquestioned higher fuel economy of the Diesel motor over that of the steam engine.

The principal characteristics of these two vessels are given as follows:

Length between perpendiculars	455 feet
Beam	56 feet
Draft (loaded)	26 feet 4 inches
Tonnage (loaded), about	15,000 tons
Speed (loaded)	14.5 knots
Cargo capacity, fuel oil	10,000 tons

The main propelling machinery of the *Maumee* is being built at the navy yard, New York, and consists of two single-acting, two-cycle, six-cylinder, Diesel engines of the slow-speed, cross-head, heavy-duty type. Each engine will develop its full power of 2,500 brake horsepower at 130 revolutions per minute.

In order to gain a maximum of Diesel-engine experience in a minimum of time, the Bureau of Steam Engineering decided to obtain the manufacturing rights and a set of working plans from some company already engaged in that line of work, and to build the engines in one of the navy yards. The Navy Department, therefore, obtained bids from various shipbuilding and manufacturing companies, both at home and abroad, and finally contracted with the Electric Boat Company, of Groton, Conn., American licensees of the Maschinenfabrik-Augsburg-Nurnberg, or M. A. N. Company, of Nuremberg, Germany.

The Electric Boat Company, through a subsidiary company, the New London Ship and Engine Company, manufactures two-cycle, single-acting Diesel engines of the M. A. N. type for submarines and other marine work. This company also manufactures a four-cycle Diesel engine for marine use, but up to date has not constructed engines of the heavy-duty, slow-speed type used in ocean-going vessels.

The contractor obtained the original design and drawings from the home company, translated all figures from the metric to the English system, and supplied the Government with a set of retraced plans, whereon only slight departures from the original design were made. The navy yard, New York, checked the translated drawings by comparison with the original German drawings, and, after approval by the Bureau of Steam Engineering, built the engines, following the drawings as closely as conditions would permit. It will not be out of place here to observe that it would probably have been cheaper to build the engines using the original metric figures and scales. All the translated figures contained decimals to the thousandth part of an inch, which made the checking extremely tedious, and the work in the shop, where English scales were used, slower than it would have been otherwise. The decimals made it difficult for the man at the machine tool to distinguish between important and unimportant dimensions, so that the result showed considerable time spent in making all dimensions correct.

All parts of the engine were made in the navy yard, except the very few steel castings required, and the heavy connecting rod, piston rod and thrust and line shaft forgings. These forgings were purchased rough turned and finished in the yard. The crankshaft was purchased from the Erie Forge Company, of Erie, Pa.

Each main engine, turning outboard going ahead, drives the following attached auxiliaries:

Three high-pressure air compressors for fuel injection and for charging air starting bottles.

Three scavenger compressors for cylinder scavenging.

Two salt-water pumps for cooling all water-jacketed parts of engine except pistons.

One fresh-water pump for piston cooling.

One lubricating oil pump for thrust block, main, crankpin, and crosshead bearing lubrication.

Two general service water pumps for fire, bilge or sanitary purposes.

Twelve mechanical lubricators for cylinders and for minor bearing lubrication.

One fuel oil supply pump for pumping fuel from ship's bunker tank to engine supply tanks.

Six fuel oil measuring pumps for supplying fuel to cylinders from engine-room tanks.

One speed governor, one tachometer and one revolution counter.

The diameter of the cylinders in each engine is 25.197 inches. The length overall of each engine is 52 feet 4.63 inches, and the height from the centerline of the crankshaft to the centerline of the cam shaft at the cylinder heads is 18 feet 9.197 inches.

One of the pair of engines is practically complete and has been given exhaustive trials on the test bed in shops at the navy yard in Brooklyn. It will be several months, however, before the engines have been installed in the *Maumee*, and service trials can be carried out at sea for comparison with the performance of her sister ship propelled by steam power.

At the shop tests the engine was operated on an oil similar to the standard grade of fuel oil used in the steam boilers on vessels of the United States Navy.

New French Liner *Lafayette* for New York Service

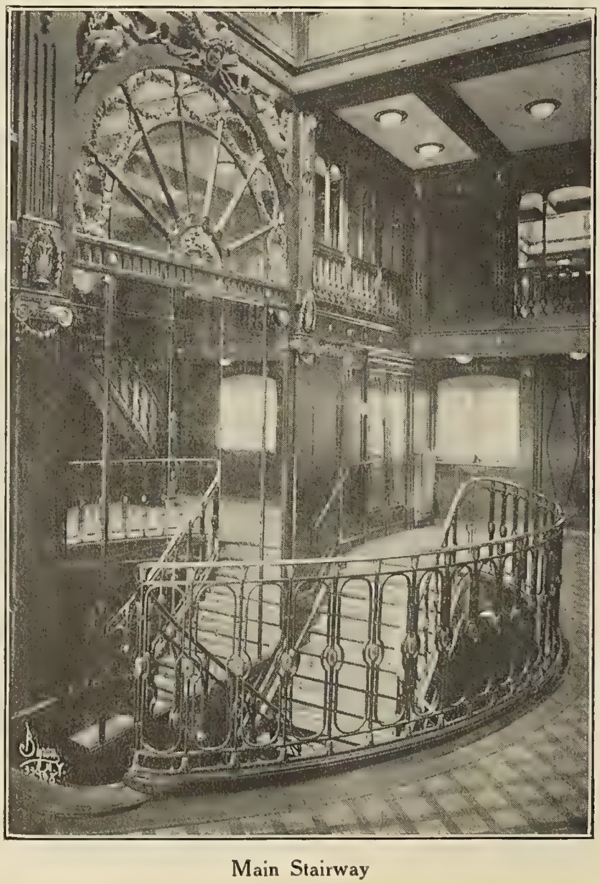
New Quadruple Screw Steamship Lafayette

French Line's Service to New York Augmented by Addition of Swift Modern Vessel of 12,000 Tons and 14,400 Horsepower

Recently the Compagnie Général Transatlantique has found it necessary to increase its transportation facilities between French ports and New York by the addition to its present transatlantic fleet of the new quadruple screw steamship *Lafayette*, of 12,000 gross tons and 14,400 horsepower, illustrated on this page.

The *Lafayette*, which is a sister ship of the *Espagne*, is built of steel to the highest requirements of French naval construction, with double hull and numerous watertight compartments. Propulsion is by combination reciprocating and turbine engines actuating four screws. In accordance with the latest requirements the most modern equipment and appliances for safety of life at sea have been provided. Life rafts have been discarded and a complete equipment of thirty-eight Lundin lifeboats has been installed with Welin launching davits.

French Line ships have long been noted for the character and quality of their interior fittings and for the comfort, convenience and luxury provided for their passengers. In these respects the *Lafayette* fully maintains the reputation established by her predecossors. The public rooms are of ample size, exquisite in appointments and luxuriously furnished. Both first and second class accommodations are provided. The suites de luxe and the cabines de luxe are situated on the boat and promenade decks, thus having plenty of outside light and natural ventilation. The promenade deck is long and spacious and the forward portion is sheltered by thick plate glass panels.

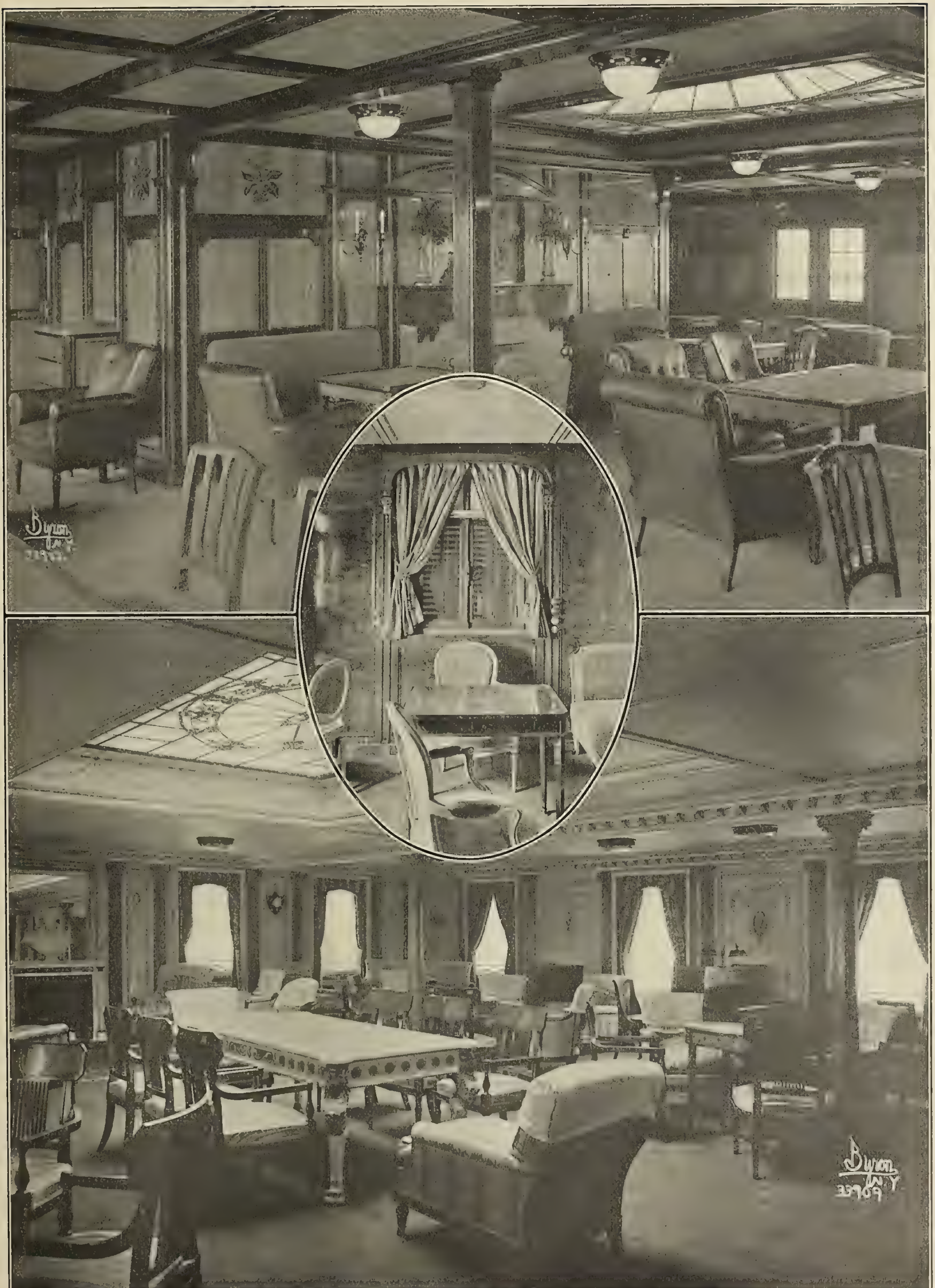


Main Stairway

Special provision has been made for the care of children on the ship, including a playroom of generous size and also a Punch-and-Judy theater, which is a novelty on board ship.

In addition to the special suites, all of which are provided with bath and toilet, other first class cabins are provided on the upper deck, each furnished with a lower berth and sofa. All of these cabins are supplied with hot and cold running water, with direct outlet to the sea. In addition to natural ventilation for the cabins, electric fans draw in fresh air from the outside and force this into ducts leading to all the staterooms. This fresh air supply can be controlled within each stateroom independently of the other rooms. The reading, writing, social and smoking rooms are all of large size.

The *Lafayette's* maiden voyage to New York was successfully completed in November.



Upper View—First Class Smoking Room. Lower View—First Class Drawing Room. Inset—Cabin de Luxe

(Photograph copyright by Edwin Levick, New York)

Fig. 1.—Houseboat *Captiva*. Designed by Gielow & Orr for Mr. Harry Payne Whitney

Shallow-Draft Houseboats for Yachtsmen

Large Power Boats Recently Designed by Gielow & Orr, of York, for Navigating Inland Waters

The characteristics of the Atlantic coast of the United States, as well as of the inland bays and navigable streams, furnish a wide diversity of cruising grounds for pleasure power boats. For a vessel of this type to be serviceable in the inlet and bays of the New England coast and down to the sunny lagoons, shallow streams and inland bays of Florida, a craft is required which combines the seagoing qualities of a good motor yacht with the more material comforts of a roomy houseboat. Light draft is essential for winter cruising in southern waters, and a fair amount of speed and seagoing qualities are also required to enable the owner of such a boat to make the long run between the winter and summer cruising grounds.

Many craft of this type have been designed by Messrs. Gielow & Orr, of New York City, during the past fifteen years, two of the latest of which are illustrated herewith.

(Photograph copyright by Edwin Levick, New York)

Fig. 2.—Dining Saloon of the *Captiva*

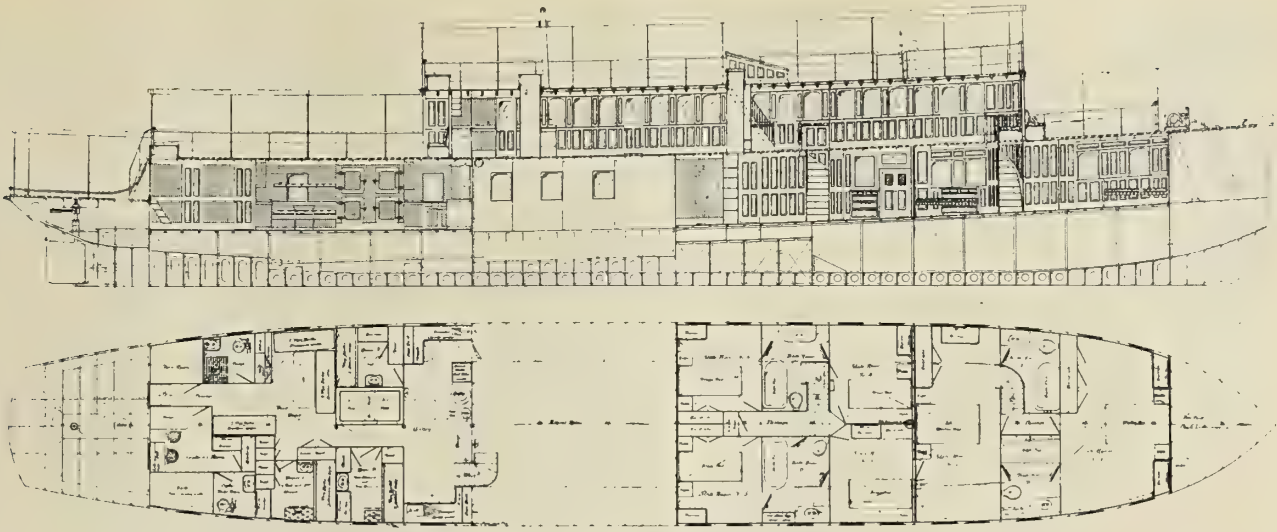
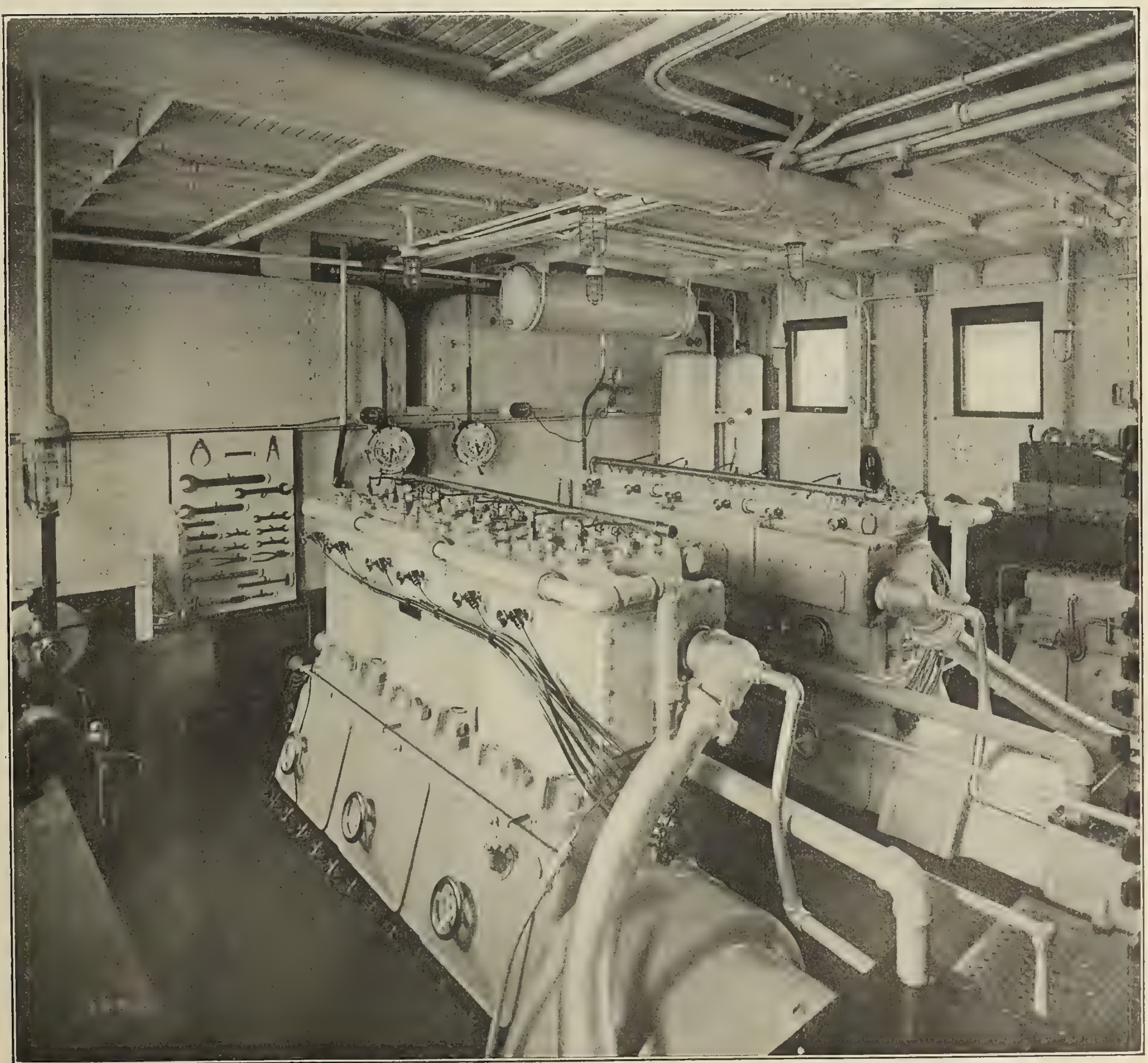


Fig. 3.—Profile and Deck Plan of the *Captiva*



(Photograph copyright by Edwin Levick, New York)

Fig. 4.—Engine Room of the *Captiva*, Showing Two 200-Horsepower, Six-Cylinder, Winton Motors

Fig. 5.—Main Living Room

Fig. 6.—Stateroom

The first is the *Captiva*, built by J. W. Sullivan, New York, last May for Mr. H. P. Whitney, of the New York Yacht Club. The boat is of steel, 130 feet 6 inches long overall, 121 feet long on the waterline, 21 feet beam and 4 feet draft, fully loaded. Tht hull is divided into six watertight compartments by five transverse bulkheads. The keel is of the flat plate type, 48 inches wide, of No. 2 B. W. G., with the vertical keelson of No. 4 B. W. G. 18 inches amidships increased at the ends. The frames are 2½-inch by 2½-inch by 4.1-pound angles, and the reverse frames 2-inch by 2-inch by 3.2-pound angles. The floors are of steel plate, No. 4 B. W. G., and the deck beams of 3-inch by 2-inch by 4.1-pound angles. The plating is of steel, ranging from No. 2 to No. 5 B. W. G., worked in in-and-out strakes, and extending up to the upper deck.

The deckhouse of mahogany is 62 feet long, with a mean width of 13 feet 6 inches. In the forward end is the main saloon or social hall. Immediately aft is the lobby and chart room, while next comes the dining room and pantry. The owner's and guests' quarters are in the forward part of the vessel and occupy the entire width for a fore-and-aft distance of 50 feet 6 inches. Amidships is the machinery space and aft of that the galley and officers' and crew's quarters.

The propelling machinery consists of two 200-horsepower, six-cylinder Winton gasoline (petrol) motors, manufactured by the Winton Gas Engine & Manufacturing Company, of Cleveland, Ohio, with cylinders 9 inches diameter by 14 inches stroke, driving 46-inch propellers designed to give the vessel a speed of 14 miles per hour. The engines are entirely enclosed with two separate sets of magnetos and two spark plugs in each cylinder. The gasoline (petrol) tanks have a capacity of 6,000 gallons. Among the auxiliaries are two 5-kilowatt Winton electric lighting sets, supplying current for a searchlight, electric pumps, compressors, storage batteries, etc. There is also a refrigerating and ice-making plant and steam heating plant.

Another boat of similar type was recently built at Manitowoc, Wis., for Honorable James D. Cameron, from designs by Messrs. Gielow & Orr, of New York. This is the *Conewago*, which is constructed of wood throughout, 100 feet long overall, 90 feet 9 inches length on waterline, 18 feet beam under guards, with a full load draft of 3 feet. The boat has a deckhouse of mahogany arranged with an observation and smoking room forward and a dining room and pantry aft. Below decks are the owner's stateroom, six guests' rooms, a large galley, the engine room, and finally, in the stern, accommodations for the officers and crew.

The propelling machinery consists of two Winton gasoline (petrol) engines, manufactured by the Winton Gas Engine & Manufacturing Company, of Cleveland, Ohio. These engines each have six cylinders, 6½ inches diameter by 9 inches stroke, which are capable of driving the boat at a maximum speed of 11 knots and a normal cruising speed of 10 knots. The fuel tanks have a capacity sufficient to give a cruising radius of 1,200 miles.

The *Conewago's* first run from the builders' yard at Manitowoc, Wis., to New York City by way of the Great Lakes, down the St. Lawrence River and then down the Atlantic coast, covered a distance of 3,186 miles. The trip was made in 13 days and 7 hours' actual running time, the fuel consumption for the entire trip being 2,540 gallons of gasoline (petrol) or .8 gallon per mile.

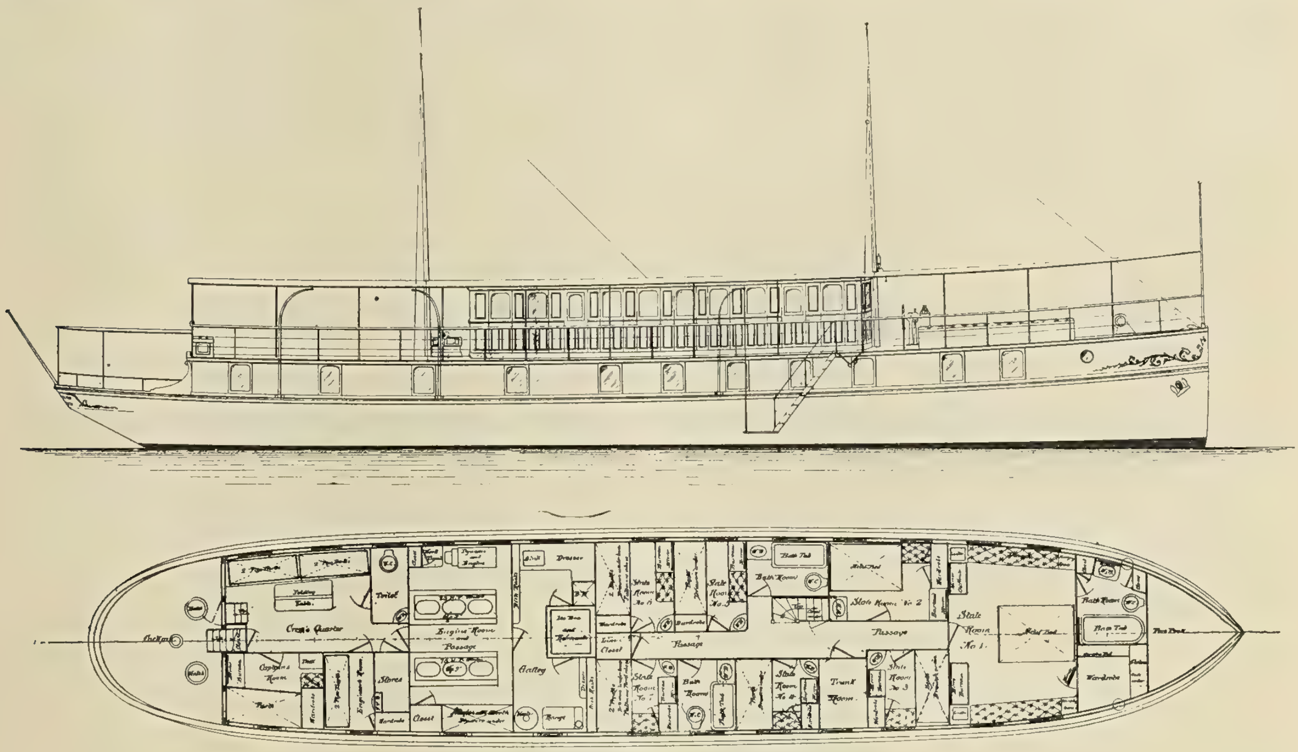


Fig. 7.—General Plans of Houseboat *Conewago*

NEW ITALIAN TRANSATLANTIC LINER.—The new twin-screw steamer *Giuseppe Verdi* of the Transatlantica Italiana Line, built especially for the service between New York, Genoa, Naples and Palermo, reached New York on November 19 on her maiden voyage. She is 505 feet 3 inches long over all, 480 feet long between perpendiculars,, 59 feet 8 inches beam and 37 feet depth. Her gross tonnage is 9,773 and she was designed for a service speed of 18 knots. Accommodations are provided for 96 first class, 135 second class, 100 intermediate and 1,792 steerage passengers.

Naval Architects' Annual Meeting

Twenty-third Convention of the Society of Naval Architects and Marine Engineers—Abstracts of Principal Papers Read

The twenty-third annual meeting of the Society of Naval Architects and Marine Engineers was held at the Engineering Societies Building, New York, on November 18 and 19. Colonel Robert M. Thompson, president of the society, presided at the professional sessions, which were held both morning and afternoon of each day of the convention, and also acted as toastmaster at the annual banquet which was held on the evening of the nineteenth at the Waldorf Astoria hotel, where the all-important question of military preparedness was discussed from many points of view.

The annual report of the secretary-treasurer showed that the membership of the society at the close of the annual meeting in 1914 was 813. During the past year the society lost fifteen members by death, while seven resigned. During the meeting, however, thirty-six new members were elected. From November 1, 1914, to October 31, 1915, the total receipts were $11,329.75 (£2,320) and the total disbursements $10,138.67 (£2,080). The total resources of the society are $29,408.22 (£6,025) and its total liabilities $595 (£122), making the society's present worth (on October 31, 1915) $28,813.22 (£5,903), divided as follows: Working capital, $15,368.22 (£3,150); endowment fund, $12,560 (£2,575), and income earned, $885 (£178).

The following deaths were recorded during the year: G. A. Bisset, A. J. DuBois, Charles A. Harrington, Henry S. Hayward, John B. Hereshoff, Albert L. Hopkins, John Lloyd, Alexander J. Maclean, Frederick G. Rogers, Charles Ward, Jacob R. Andrews, Ransford D. Bucknam, Harrison B. Moore, D. S. Vassilieff and Revere B. Pulsifer.

The officers elected for the coming year were as follows: President, Stevenson Taylor; vice-presidents (term expiring December 31, 1918), H. I. Cone, Lewis Nixon, G. W. Dickie, G. E. Weed; members of council (term expiring December 31, 1918), H. A. Magoun, W. J. Baxter, Andrew Fletcher, R. H. Robinson, W. D. Forbes, W. G. Coxe; associate members of council (term expiring December 31, 1918), J. S. Hyde, H. D. Goulder. D. H. Cox was re-elected secretary-treasurer.

The following were elected to membership in the society:

Life Associate Member.—Colonel Robert M. Thompson, New York.

Members.—Cornelius A. Binks, superintending engineer, New York & Cuba Mail Steamship Company, New York; Frederick H. Chase, naval architect, Tams, Lemoine & Crane, New York; Andrew W. Christian, assistant to the president, Harlan & Hollingsworth Corporation, Philadelphia; Neils Christiansen, superintendent of machinery, Newport News Shipbuilding & Dry Dock Company, Newport News, Va.; Albert C. A. Holzapfels, vice-president, Holzapfels, Ltd., New York; Russel C. Jones, manager, marine department, Griscom-Russell Company, New York; George F. Lawley, president, George F. Lawley & Son Corporation, Neponset, Mass.; Johan H. Lindroos, draftsman, Cox & Stevens, New York; John S. Leitch, general manager, Collingwood Shipbuilding Company, Collingwood, Ont.; David Millar, surveyor, Lloyd's Register of Shipping, Baltimore, Md.; Joseph F. Moran, vice-president, Atlantic Basin Iron Works, Brooklyn, N. Y.; Kurt A. W. Orbanowski, naval architect, New York; Evangelos D. Papayannis, naval constructor, Royal Hellenic Navy; William W. Smith, engineer, Westinghouse Machine Company, East Pittsburg, Pa.; John F. Wentworth, draftsman, Navy Yard, Boston, Mass.; Cecil W. Weaver, marine estimator, Pusey & Jones, Wilmington, Del.; Ludwig Anderssen, ship and engine surveyor, New York; Henry Holmes, assistant engineer, Esplen & Sons, New York; James McNaught, manager, Esplen & Sons, New York; Frederick J. Smith, superintendent, machine shop, Robins Dry Dock & Repair Company, Brooklyn, N. Y.; Louis N. Lacombe, assistant superintendent, Robins Dry Dock & Repair Company, Brooklyn, N. Y.; Samuel Bennett, surveyor, American Bureau of Shipping, Newport News, Va.

Associates.—Norman R. Dutton, designer, marine machinery, Pusey & Jones Company, Wilmington, Del.; Charles F. de Ganahl, president, Tampico Navigation Company, New York; James A. Guthrie, Jr., marine adjuster, insurance department, Pennsylvania Railroad Company; Von-Fong Lam, student, Massachusetts Institute Institute of Technology, Boston, Mass.; John A. McGregor, president, Union Iron Works, San Francisco, Cal.; Charles H. Macdonald, Art Metal Construction Company, New York; Leigh R. Sanford, United States Engineer Office, Rock Island, Ill.; Henry E. Rossell, assistant naval constructor, U. S. N., Navy Yard, New York.

Juniors.—Henry C. Adams, Jr., shipfitter, New York Shipbuilding Company, Camden, N. J.; Clay L. Jennison, draftsman, United States Coast Guard, Washington, D. C.; Carl E. Petersen, draftsman, Morse Dry Dock & Repair Company, Brooklyn, N .Y.; Philip H. Thearle, draftsman, San Diego Marine Construction Company, San Diego, Cal.; George Laing, Jr., surveyor, the Vessel Agency, New York; Linn M. Rakestraw, student, University of Michigan, Ann Arbor, Mich.

The following are abstracts of the papers read and discussed at the meeting:

Aerodynamical Experiments Upon a Yacht's Mainsail

BY PROFESSOR H. A. EVERETT

ABSTRACT

Experiments were carried out in the aerodynamical laboratory of the Massachusetts Institute of Technology in January, 1915, to determine the possibility of obtaining reliable information concerning the action of sails in the wind. The work resulted in the determination of the location of the true center of pressure, the normal pressure per unit of area for a given wind velocity, and the proper angle of boom to center line for fastest sailing on a given course.

The experiments were carried out with a single sail (a mainsail), as the adoption of two (jib and mainsail) would have injected an indeterminate feature, the inter-relationship between them due to variations in sheet trimming. The sail used was an exact reproduction of a successful sail as used on one of last season's, Class P, racing yachts, and was made accurately to the scale of 3/8 inch to 1 foot of light, firm China silk. It was made out of a single piece of silk, no attempt being made to reproduce seams, but the roach at the leach of the sail was the maximum which the rule permits and was held out by miniature battens. The sail was carefully cut and made by Wilson & Silsbee in exact conformity with their cutting plan for the full-sized sail.

In carrying out the tests it was considered undesirable to have any sort of body under the sail to which the main sheet could be made fast, as this would inject a disturbing factor into the action of the wind on the sail by disturbing the air flow to the sail, therefore the boom (of 3/16-inch steel tubing) was rigidly attached to the mast (of 5/16-inch steel tubing) at an angle which represented the normal setting of the sail. The gaff was free to swing off and take up whatever position the wind drove it into. The sail was set by throat and peak halyards as nearly as possible in exact conformity with the setting of the actual sail. The sail was provided with battens correct to scale, the attachment to the boom and gaff was by the customary lace lines, and the luff was held to the mast by small brass rings. The sail was vertical at all times, no attempt being made to simulate heel.

The experiments were made possible by the facilities of the aerodynamical laboratory or "wind tunnel" recently established at the Institute in connection with the Department of Naval Architecture under Prof. C. H. Peabody. Their successful conclusion was largely dependent on the hearty co-operation of Assistant Naval Constructor J. C. Hunsaker, who is in direct charge of the aeronautical instruction and this laboratory. The "wind tunnel" consists of a square duct 4 feet on a side through which a current of air is drawn at uniform velocity with a balance under it which supports the models to be tested and weighs the different forces acting on them.

The method of carrying out the observations was to set the sail with the plane of the boom and mast parallel to the center line of the wind tunnel, then by turning the boom up stream to known angles with the center line to measure torque and the moment of the thrust in the direction of the wind and at right angles to it. A plane passed through the boom and mast was considered the plane of reference for all settings. The twisting moment or torque about the mast was measured by the torsional distortion of a calibrated wire in the extension of the axis of the mast. The balance which was used for this work is a copy of the one in use in the National Physical Laboratory in Great Britain, and was built under their direction by the Cambridge Scientific Instrument Company especially for the Institute. It is a remarkable combination of ingenuity and extraordinary instrument-making skill, and has been used extensively for the regular aerodynamical experiments carried out in the laboratory. The observations for thrust and torque were taken for each angle with the speed of the wind maintained constant at 15.1 miles per hour. When the observations of thrust had been completed for all angles the settings were repeated at the same wind velocity for measurements of torque or moment about the mast, as both thrust and moment cannot be measured simultaneously on the balance.

In order to determine the effect of varying wind intensity some of the runs were repeated for winds of approximately 10 miles and 20 miles per hour. It was thought that intermediate points could be filled in by cross fairing from the similar curves derived for 15 miles per hour.

Observations were taken of the moment of the component of the wind pressure on the sail acting along the wind and of the moment of the component acting across the wind and of the moments of the resultant or total pressure about the mast. This gave four equations which, however, contained five unknowns. By repeating the first two observations, with the length of the vertical arm shortened 6 inches, two more equations were added without increasing the number of unknowns, which resulted in six equations involving five unknowns. The unknowns were: First, the transverse component of the wind pressure; second, the down-stream component; third, fourth and fifth, the co-ordinates of the center of pressure, measured respectively along the wind, across the wind, and vertically, origin at the intersection of the bottom of the boom with the center line of the mast. The known quantities were the weights on the scale beams, the torque and the length of the weighing arms.

The solution of the equations gave the horizontal co-ordinates, and the square root of the sum of their squares gave the distance along the boom at which the resultant pressure may be considered as acting. The determination of the vertical co-ordinate was perhaps the least precise of any of the characteristics, as its derivation involved the difference between the readings obtained with the arm at its original length and when shortened. In some cases this resulted in a small difference of two large quantities.

The components of the wind pressure on the sail acting along the wind and across the wind were derived directly from the equations and their resultant gave the resultant wind pressure in magnitude, direction, and point of application. Therefore it was possible to plot this resultant wind pressure in its true location and to scale for the different angles of boom to wind. The maximum resultant pressure occurred at an angle of boom to wind of 110 degrees, which was not unexpected when it is noted that the gaff was then at about 80 degrees with the wind and one might consider that the mean line of the sail was at practically 90 degrees. (All angles were measured up stream from the initial position of the boom.)

The maximum pressure with the wind at 15.1 miles per hour amounted to 0.885 pound per square foot, using the net area of the sail. It is probably more correct to include the projected area of the boom, mast and gaff and use the total area. This gives for the maximum pressure 0.833 pound per square foot. Eiffel's formula for the resistance of curved surfaces (camber 1 in 7) at 90 degrees with the wind, gives for this case 0.825 pound per square foot, which is an interesting agreement lying well within the accuracy claimed for either experimental work. It would seem that this formula of Eiffel's was applicable to the determination of maximum wind pressure for yachts, provided the area of spars, etc., is included in the area.

It is interesting to consider on what direction of sailing the ship is driven the fastest by this sail. If we assume that the hull resistance is the same for all courses and is not affected by different angles of heel, the course which is at 190 degrees with the wind is the one on which the boat will go the fastest. For this course the best angle which the boom should have with the center line of the boat is shown to be about 88 degrees. It should be remembered that this applies to the single sail rig only.

A very interesting point to be noted is that *for courses from 45 degrees to 160 degrees with the apparent wind* (shown by the fly at the mast head), *the angle between the boom and center line of ship* for best sailing, with this sail, *should be approximately one-half the angle between the fly at the masthead* and the *centerline of the ship.*

In all of the work so far considered no distinction has been made between real and apparent wind, but in applying the work to a yacht the wind which is customarily observed is that indicated by the fly at the mast-head. This is the apparent wind, and it is the resultant of the speed of the boat and the true wind. It is obvious that the wind of the tunnel experiments corresponds to the apparent wind. If it is desired to find the relationship between the apparent wind and the real wind or the relationship between the real wind and the courses, an estimate of the speed of the yacht in terms of the speed of the wind must be assumed, and then it will be possible to obtain the direction of the true wind.

Inland Navigation and Barge Construction Versus Floating Bridges

BY J. H. BERNHARD

ABSTRACT

In this paper the author takes the stand that the average Western river steamboats, costing $70 (14/11/8) per net ton cargo capacity are of obsolete construction, and attributes the decline of transportation on the inland waterways very largely to the fact that naval architects have never put themselves seriously at work to replace these river steamers with more modern and economical carriers. As a solution of this problem, he describes the steel self-propelled barges of 1,000 tons carrying capacity, built according to his ideas for navigation between New Orleans, La., and Tuscaloosa, Ala. These boats have been operated successfully carrying freight over this route a distance of 1,050 miles and returning empty at a total cost of 40 cents per ton, or about 3/8 mill per ton mile, one-tenth of the average railroad charge. In these boats the cargo is placed on deck, there being no hatches in the deck. By placing the cargo on the deck the entire hold is available for strengthening purposes and for placing the structural braces at the best possible advantage. The result was that very light material was used, the hull being built of 1/4-inch plate and the frames of 2 1/2-inch by 2 1/2-inch by 1/4-inch angle iron. Although the barge carries 1,000 tons net, there are only 170 tons of steel in her construction, and, together with the machinery, bunkers, etc., the total weight of the barge is only 240 tons. At full load these barges displace 1,240 tons of water, were given a speed of 8 miles per hour with only 150 horsepower, using for this purpose gas-producer engines burning breeze coke, which brought the cost down to 1/10 cent per horsepower per hour.

From this experience the author has recently organized a company for establishing a line of self-propelled barges on the Mississippi River. The barges will be divided into two classes—speedy and slow. The speedy barges will be 310 feet long, 56 feet wide and 9 feet deep, with a draft of 7 feet, propelled by four 600-horsepower engines, estimated to give a speed of 20 miles in slack water, 22 miles down stream, and 17 1/2 miles up stream. The slower barges, of which the first is now nearly completed, will be 240 feet long, 42 feet wide, capable of carrying 1,500 tons on a draft of 7 feet, and 500 tons on a draft of 3 1/2 feet. These barges were described in the November issue of INTERNATIONAL MARINE ENGINEERING.

Recent Progress with the Active Type of Gyro-Stabilizer for Ships

BY ELMER A. SPERRY

ABSTRACT

As the result of noteworthy experiments on board the U. S. S. *Worden* with the active type of gyro-stabilizer, it has been established that the gyroscope is useful in solving certain problems at sea, and orders have been issued by the Navy Department for fitting permanent plants, thus putting it into practical service. Since this work further investigations have been in progress. Among these have been determinations of the exact amount of the true wave increment the gyros are required to neutralize, involving the relation of the gyro-quenching increment to the natural extension curve of roll of the ship. It is gratifying to note that all of this work has proven the soundness of the basic formula originally laid down by Naval Constructor Taylor, in course of which he points out that gyro moment of stabilizer equipment for ships varies directly as the characteristic of the ship—i. e., the product of the displacement, the metacentric height and period of roll. There is no variation from this rule involved in the fact that it has been definitely ascertained that small boats require relatively larger moments or greater stabilizing power than is the case with larger ships. This means that waves of given magnitude belabor small ships more than they do large ones, which is to be expected, and therefore require relatively more roll-quenching power to be fitted. Again, it is possible to adjust the plant in other ways to meet special conditions, such, for instance, as limited space, met with in the case of submarines; limited weight, which is the case where the gyro is placed on deck, as in the motor yacht *Widgeon*, and which is also the case with submarines; then again the condition where a limited power supply is available for spinning the gyro or gyros and handling the equipment.

Inasmuch as the roll-quenching power of the gyroscope varies as the square or its diameter and only directly as its speed and weight, and inasmuch as another factor—i. e., the power required for spin at the higher rates—varies almost directly as the cube of the peripheral velocity, it will at once be seen that where ample space is available and the matter of weight is not critical the rotor and spread of bearings may be so adjusted as to require a minimum of power for maintaining the spin of the wheel for a maximum of gyroscopic moment; and vice versa where only a limited space and weight are permissible and an abundance of power available, a small gyro spinning at higher velocity may be utilized for developing comparatively large stabilizing moments.

The first commercial gyroscope stabilizing equipment to be installed has been placed upon the yacht *Widgeon*, plying on the Great Lakes. This was placed in service in the autumn of 1915, and is of the full active type. The characteristics of the *Widgeon* are as follows: Displacement, 165 tons; metacentric height, 1.75 feet; period of roll, over and back, 4.75 seconds; waterline length, 120 feet; waterline beam, 18 feet 2 inches; total submerged midship section, 80 square feet.

For this ship the total weight of the gyro equipment is about one percent of the displacement. The yacht was looked upon as being a very free roller and after the gyro was installed it was found that when the gyro was thrown "off" a free roll of from 24 to 40 degrees of total arc was quickly developed while running in the trough of the sea, and when the gyro was thrown "on" this was quickly reduced and held at 2 or 3 degrees.

The details of the plant and the method of installation and operation are described in the paper. The system of control is practically identical with that which was finally adopted in the last experiments on the *Worden*—that is, a small auxiliary gyro is employed to feel out the incipient rolling of the ship by closing small electrical contacts as soon as the ship rolls very slightly one way or the other. These contacts are required to handle only a very few watts—in fact, about one-quarter of the energy of an ordinary incandescent lamp—and through a relay switch serve to actuate a small reversing motor which constitutes the precession motor. This motor precesses the gyro upon its main supporting gudgeons at the ends of the frame; it is here that the gyro lays hold upon the ship to control its movements. Inasmuch as all rolling of ships is due to an accumulation of individual wave increments, and since each increment is checked and neutralized, the ship never starts to roll and therefore never rolls.

The plant works very smoothly and practically without noise and seems to perform its duty easily. A little reversing switch provided with nameplates plainly marked "Rolling" and "Stabilizing" allows the stabilizer to be operated to roll the boat at will. This is useful in working off from sand bars, mud banks, negotiating ice packs, etc.

In fact, this has already been found extremely serviceable in the shallow waters of Toledo inlet.

Other points that have been definitely settled by the operation of the stabilizer are as follows:

That under conditions of a strong wind which had been blowing all day, with Government storm warnings hoisted all along Lake Erie, a trip was made from Toledo to Cleveland in the evening where with the gyroscope "off" the ship rolled up to 25 degrees each side of the vertical, and with the gyroscope "on" this roll was quenched down to an average of 3 degrees or less, the interesting point being that the boat steered very much steadier and made her run in as good time as on any previous trip, including calm seas, and also while being stabilized her decks remained dry. It is gratifying to note also that the chief engineer and others who reviewed the operation of the plant have reported that they are satisfied that it is "thoroughly practicable and that there will be no difficulty in keeping it in proper operating condition."

Variation of Frictional Resistance of Ships with Condition of Wetted Surface

BY NAVAL CONSTRUCTOR WILLIAM MC ENTEE, U. S. N.

Abstract

Considering that frictional resistance is the most important element in the resistance of practically all ships, it is noteworthy that investigations of conditions affecting it have been relatively few. Although there have been many attempts made to reduce this resistance by different methods and there are many references made to its increase from fouling, there appear to be relatively little actual data as to the quantitative variations obtained. The results here given are based on a series of tests made at the United States Experimental Model Basin during a period extending somewhat over a year.

In considering this general subject, two queries naturally arise: (1) On actual ships, what is the increase in resistance due to fouling? (2) Is it possible to reduce the frictional resistance by modifications in the condition of the frictional surface, or by the application of materials which would tend to make the surface smoother?

Effect of Fouling

The method adopted to investigate this subject was to expose to fouling in sea water twelve 10-pound steel plates 2 feet wide by 10 feet long, painted with two coats of anti-corrosive paint. The plates were placed in the water July 10, 1914, at a point in the Chesapeake Bay near the navy yard, Norfolk, Va., where the water ordinarily has a density of 1.02—that is, contains about 75 percent as much salt as is ordinarily found in sea water.

The plates were removed from the water at intervals of one month, carefully packed so as not to remove any of the fouling, which consisted mostly of small barnacles, and shipped to the Model Basin, where they were tested to obtain the frictional resistance.

Each plate as received at the Model Basin was tested at speeds ranging from 1½ knots to 8 or 9 knots, and gave results shown in Table I. After this the plate was carefully cleaned, scraped and repainted with a coat of Norfolk anti-fouling paint and retested at the same range of speeds as when fouled, and the coefficient and exponent for the clean condition determined. The fouling matter removed from the plates was weighed so as to give a measure of the amount of fouling.

It will be seen that the maximum increase is such that the resistance when foul is four times as great as when the plate is clean and freshly painted.

Referring to Table I it will be seen that not only does the coefficient of friction increase greatly, but that the exponent in the formula, $R = SfV^n$ also increases and has a value averaging about 2.00 as compared with the value of about 1.88 for the clean plates.

These results indicate the importance of keeping a vessel's bottom clean and well painted, though it is not considered that the relative effect on a ship's resistance due to an equal amount of fouling would actually be as great as that obtained in these experiments, as it seems probable that the decrease in frictional coefficient due to increase of length would be relatively greater for the foul condition than is found to be the case for clean, smooth surfaces.

Effect of Lubrication

At various times attempts have been made to reduce the frictional resistance of ships by lubricating the underwater surface or by polishing it to a high degree of polish with various materials. One favored method used for racing yachts is to polish the bottom with black lead or graphite. An investigation of the benefits to be expected from such polishing or lubrication has recently been made at the Model Basin with two friction planes, which were roughly 20 feet by 2 feet by ¾ inch, with ends sloped forward at an angle of about 30 degrees. Total wetted surface for each is about 82 square feet. The planes were sandpapered smooth and coated with shellac, and in this condition were each towed in the water at speeds ranging from 1 to 11 knots.

One plane was next coated with black lead or graphite, which was mixed in sour milk and applied with a brush to the shellacked surface of the plane. When dry the lead was rubbed down to a fine, smooth polish. Ten runs were made with this plane at speeds from 5.1 to 6.5 knots. The graphite seemed to cling well to the surface and showed no abrasion or wear. When wet, however, it was easily rubbed off.

TABLE I.—TABLE SHOWING INCREASE IN RESISTANCES OF PLATES WHEN FOUL AS COMPARED WITH THE SAME PLATES CLEANED AND FRESHLY PAINTED.

Months in Water. Speed Knots.	Increase in Resistance in Pounds.											
	1	2	3	4	5	6	7	8	9	10	11	12
2	0.24	0.40	1 17	2.09	2.50	2.52	2.80	2.76	2.61	2.97	3.09	3.36
3	0.72	0.88	2.83	4.94	5.79	5.72	6.45	6.31	6.17	6.93	7.28	7.78
4	1.48	1.56	5.19	9.09	10.53	10.22	11.79	11.38	11.02	12.75	13.39	14.20
5	2.55	2.45	8.41	14.59	16.71	16.08	18.55	18.03	17.32	20.30	21.40	22.50
6	4.02	3.54	12.42	21.40	24.32	23.20	27.20	26.16	25.13	29.83	32.43	33.07
7	6.77	4.74	17.35	29.60	33.45	31.70	37.00	35.95	34.23	41.15	43.4	44.65
8	7.82	6.20	22.90	......	44.20	41.60	48.65	47.50	44.80	54.50	56.8	60.10
9	10.40	7.75	29.40	......	56.35	52.85	......	......	56.95	69.85	......	......
10	......	......	......	......	......	......	......	......	......	......	......	......
Coef. foul plate	0.01138	0.01282	0.01667	0.0239	.0255	.0252	.02745	.02666	.0275	.0285	.0273	.0292
Exp. foul plate	1.994	1.928	2.029	2.002	2.003	1.988	2.000	2.000	1.967	2.015	2.055	2.035
Coef. painted plate	0.01071	0.01004	0.01000	0.01189	.0108	.0095	.0108	0.01013	.01075	.00903	.0096	.0095
Exp. painted plate	1.869	1.918	1.937	1.855	1.874	1.938	1.880	1.912	1.869	1.848	1.914	1.924

Coef. = Coefficient. Exp. = Exponent in formula $R = Sf\,V^n$.

The next material tried was ordinary Ivory soap, which was mixed as a thick emulsion in water and applied with a brush. The plane was run at speeds from 6 to 9 knots. The soap left a whitish streak in the water the first run, but not thereafter. The resistances obtained on all of the runs were consistent, so that the quality of the surface was probably unchanged during the course of the experiments.

Two other lubricating materials experimented with were heavy cylinder oil and light cylinder oil. The oil was applied to the shellacked surface of the plane when dry with a brush, the plane being suspended over the position in which it was attached to the towing carriage, so that it could be run in the water as quickly as possible after the application of the oil. The plane with the heavy engine oil was run at speeds from 6 to 8½ knots. The observations obtained were consistent, but the slope of the resistance line when plotted on log paper indicated that at speeds of about 3 knots the frictional resistance would fall below that of the smooth, shellacked surface. This peculiarity is possibly due to the fact that parts of the oil formed in drops or globules and wavelets. increasing as the speed increased, thus changing the condition of the surface which might, if tested at lower speeds, not have given results lower than shellac.

The experiments with the light engine oil indicated that for the first two runs the resistance was a small percentage greater than for the shellacked surface. Apparently as the oil was washed off the resistance decreased until the resistance agreed with that previously obtained with shellac.

The results of the experiments indicate that no advantage over a smooth varnish or shellacked surface is obtainable with the materials used. For each lubricating surface the resistance is greater than for the shellacked surface. The resistance increases in the following order: Black lead, light engine oil, Ivory soap, heavy cylinder oil.

The lubricating surfaces were tried only over a limited range of speeds, from 6 to 9 knots, as it was thought that the exponent in the formula $R = SfV^n$ could not be used. owing to the changing condition of the surface due to the washing off of the lubricating material. Actually it was found, however, that the light engine oil was the only material for which the resistance changed rapidly, and that washed off quickly so that the resistance came down to that for shellac.

In Table II is given a tabular comparison of the results:

TABLE II.—WITH CONDITION OF WETTED SURFACE.

Surface.	Plane.	Area Sq. Ft.	Coef. of Friction.	Exponent.	Net Resistance at 7 Knots in Lbs.	Percentage Increase in Resistance at 7 Knots.
Shellac	AB	82.12	.00878	1.883	28.1	....
Shellac	CD	82.20	.00849	1.886	27.4	....
Black lead	CD	82.20	.00866	1.886	27.9	2
Light engine oil	AB	82.12	......	.....	28.3	5*
Ivory soap	AB	82.12	.01045	1.898	34.5	23
Heavy cylinder oil	CD	82.20	.00484†	2.38†	40.5	48

* At 6 knots.

† This low coefficient of resistance is combined with a high velocity exponent and probably would become greater at speeds lower than those at which experiments were made.

The Determination of the Resistance of Ships;—Present-Day Status of the Art

BY ERNEST H. RIGG

This paper gives a very general résumé of published information bearing on the effect on resistance of increased beam, the effect of wind and sea, shoal water and temperature and the appendage resistance and the advantage of adopting cruiser sterns. The author calls attention to the desirability of a uniform system of notation throughout technical literature and recommends the system used by Taylor and Sadler, as it is ample, clear and direct. He also points out the advantage of testing in a model tank models of practically every naval or passenger vessel and enough models of cargo vessels to cover a useful range of types so that each shipyard can know whether their "lines" are good and make improvements from time to time as experience points out. The paper is briefly summed up with the following recommendations: For large cargo ships and practically all motor ships a twin screw drive is the most efficient. Further light is desirable on vibration problems, especially for vessels with machinery aft. Speed and stability are intimately associated and generally pull at cross purposes: the temptation to small beam, high speed and comfort at sea for passengers may be yielded at the price of safety in accidents. The passing of the very full cargo ship in favor of a somewhat finer type is commendable. Cruiser sterns for twin or triple screw ships are decidedly to be preferred to the older type of counter. Appendage resistance is generally very small in single screw merchant ships, but cannot be watched too carefully in multiple screw and faster types. Closed shaft bossings are generally preferable to open brackets. Progressive trials should always be made of important ships and of enough cargo ships in load condition to check up model tank and propeller performances. Flared bows above water are now well established and undoubtedly improve performances at sea. Large apertures with propellers well back from the post and ability to unship propellers without withdrawing the tail shaft are to be strongly recommended.

An incomplete bibliography is added which is intended to cover the subjects taken up in the paper.

Results of Model Tank Experiments to Determine the Action of a Ship Brake

BY CAPTAIN WM. STROTHER SMITH, U. S. N.

Abstract

This paper is presented with the idea of showing the interesting data obtained in the model tank at the Navy Yard, Washington, for use in determining whether or not it was feasible to design and install a brake on the side of a merchant vessel to assist in stopping a steamer when in danger of collision or grounding. The Wm. Cramp & Sons Ship & Engine Building Company furnished the lines of the steamship *St. Louis*, and a model of this vessel was constructed. The steamship *St. Louis* is 536 feet in length, 62 feet 9 inches beam, and the draft at load line was 28 feet for model experiments, the displacement being about 17,230 tons.

Three runs were made to determine the curve of speed and power before fitting any brakes, and the ten successive runs were made with different areas and settings of the brake to determine the resistances and pressures per square foot.

The following deductions are made:

The stopping power varies directly as the projected area opposed at 90 degrees to the fore-and-aft line. One pair of brakes is more efficient than two. The pressure per square foot practically decreases as the width of the brake is reduced and, by plotting curves of pressures at various speeds for different widths of brake, it is found that after a certain width is passed the pressure per square foot is not increased.

Using a pair of brakes 11.73 feet wide and 14 feet deep set normal to the direction of the vessel, the speed being 18 knots, the speed will be reduced to 15.2 knots in 500

feet, to 11.6 knots in 1,000 feet, to 7.15 knots in 2,000 feet without the assistance of the propellers in backing.

Assuming the weight of the vessel at 17,230 tons, the striking blow at 18 knots equals 247,300 foot second tons, 15.2 knots equals 176,300 foot second tons, 11.6 knots equals 102,700 foot second tons, 7.15 knots equals 39,000 foot second tons.

Using the element of time, the speed will be reduced in 50 seconds to 11.1 knots, 100 seconds to 7.35 knots, 150 seconds to 5.85 knots, 200 seconds to 4.70 knots.

To satisfy the ideas of many concerned, various forms of the brake were considered, principally with the idea of controlling the brake by power so as to open and close at will, the vessel going at full speed. The final conclusion reached—that the simplest form of brake designed to be set in the side of a vessel, to be released instantly by the officer on the bridge by throwing a lever and open by the pressure of the water without further thought; to be supplied with only enough power and mechanism to haul in the brake when the vessel was stopped or going astern and lock it fast for future use—was the only practical solution of the question. With these points in view, a type design was made for the Canadian Pacific steamship *Empress of Asia,* practical, strong and simple, for emergency use only. The officer on the bridge has but to pull a lever and the brake will open and exert its resistance. When the danger is past it requires but the attention of one man on each side to haul in and secure the brake.

Some Comparisons Relating to Electric Propulsion of a Battleship

BY W. L. R. EMMET

Abstract

The Navy Department of the United States has awarded to the General Electric Company of Schenectady, N. Y., a contract for electric propelling machinery for the new battleship *California,* which is being built at the New York Navy Yard. This ship is of the largest and most powerful class which has been adopted by the United States. Her displacement is 32,000 tons and her maximum speed is to be about 22 knots, requiring about 37,000 shaft horsepower. The contract with the General Electric Company covers two turbine-driven generating units, four propelling motors (one for each shaft), switching apparatus, cables, instruments, etc., two turbine-driven exciting units, and a complete equipment of condensing auxiliaries and ventilating blowers, all driven by motors from the exciting units. In fact, it covers practically the entire engine-room equipment except the main condensers.

Each of the auxiliary units is of 300 kilowatts capacity with a 240-volt direct-current generator geared to a high-speed, non-condensing turbine. These turbines will exhaust into the heaters, into the main turbines, or both. The motors which drive the auxiliaries will be designed for a considerable range of speed variation, so that the auxiliaries will be adaptable to economical conditions at different speeds of the ship.

The generators for the *California* are bipolar alternators, and the motors are arranged to be connected either for 24 poles or 36 poles. For economic cruising at 15 knots or less, one generator will be used with motors on 36-pole connection. For higher speeds the 24-pole connection will be used. The ship will be capable of operating at a speed of about 18.5 knots with one generator.

Speed variation with either motor connection will be effected by change of turbine speeds through the agency of variable speed governors designed to hold automatically any desired speed within usual ranges. This arrangement, which is also used in the *Jupiter,* entirely prevents racing and makes it convenient to hold a fixed speed irrespective of variations in sea, weather or steam conditions. It is thought that this feature will be valuable in fleet formations.

The steam consumption guaranteed on the *California* covers the total steam required for the main turbines and engine-room auxiliaries as described above. The conditions are 250 pounds gage pressure, dry steam, with such vacuum as can be produced under trial conditions. The guaranteed water rates per horsepower delivered to the propeller shafts are as follows:

	Pounds
At 10 knots	14.6
At 15 knots	11.4
At 19 knots	11.1
Maximum speed	11.9

Very heavy penalties are imposed in case these guaranteed consumptions are exceeded in trials, $25,000 (£5,100) per pound for the two lower speeds and $20,000 (£4,100) per pound for the two upper speeds.

At full speed the *California* propellers will make 175 revolutions per minute, this being about the lowest speed of propellers which is practicable within the space. The propeller speeds proposed for the sister ships with Parsons turbine drive is 240 revolutions per minute, and comparisons by Dyson's method indicate that this speed difference will give the *California* an advantage of about 9 percent in propeller efficiency.

The following table gives a comparison of steam consumption per effective horsepower between the *California* as guaranteed, the *Florida* and *Utah,* which are driven by Parsons turbines, and the *Delaware,* which is driven by reciprocating engines. These figures are taken from the published records of trials.

POUNDS OF STEAM TO MAIN ENGINES PER HOUR PER E. H. P.

	12 knots	15 knots	19 knots	21 knots	Prop. speed 21 knots
Florida	31.8	...	24.0	23.0	328
Utah	28.7	...	20.3	21.0	323
Delaware	22.0	...	18.7	21.0	122
California	17.3	15.2	15.0	16.4	175

Such a table as this affords the truest basis of comparison of prime movers in ships. The estimated weight of the propelling machinery without condensing auxiliaries is 530 tons, and that of the turbines originally proposed was 653 tons.

The contract price for the *California* propelling machinery with auxiliaries given above is $431,000 (£88,500). The estimates made at the New York Navy Yard indicate that this equipment will cost $200,000 (£41,000) less than the Parsons turbine equipment previously considered.

Interior Decoration of Vessels

BY HARRY B. ETTER

Abstract

The traveling public of to-day demand and are willing to pay for pleasant surroundings and comfort whether by land or sea. It is true that they get it on most of the transoceanic liners, but with the American coastwise steamers, with some notable exceptions, they are not so fortunate. I do not wish to criticise these steamers too harshly, but they are for the most part ugly from a decorative standpoint. The joiner work has to be made to suit the vessel, and it could have just as well been made to follow some good design instead of a riot of meaningless panels, moldings and pilasters. The joiner work of most of these vessels is very often of the same design from end to end, bottom to top, and bad proportion at that. It must be trying to one of refined taste to have the same

thing staring at him every place he goes for a week or so.

In working out a successful design for an interior a great many things should be considered, and care should be exercised not to have the decoration of adjoining public rooms so one will shock the other. All should blend together like one complete thing and yet not be alike. Other things to be considered are: First always, meaning; followed by balance of line, light and shade, repetition, variety of surface, choice of material, contrast and harmony of color and suitability for the trade the vessel is to engage in.

Exquisite form and proportion must be gained by extreme simplicity of beauty of line in the division of a wall surface into a series of panels, borders and moldings, separated by pilasters, columns and other architectural forms.

Simple designs well proportioned are an attraction in themselves, and an excess of elaboration should be carefully avoided. Mixture of styles does not always secure the best results. Ornaments, if used, should not attract the eye to the exclusion of the background as if it were an entirely separate part, but should be subservient to the general effect.

Furniture, upholstering, draperies, etc., should be carefully selected to harmonize with the style of the room. Too often is this neglected and a truly beautiful room spoiled by unsuitable furnishings. The designer of the decoration, if he knows his profession, can be and should be consulted in regard to all details, as he can picture in his mind what such things should be as he progresses with his work.

The interior decoration of a vessel is very often unsuited for the climate she is to trade in. While we do not want dark, hot-looking rooms for tropical climates, but something cool and airy, just the reverse may be said for vessels engaged in the colder regions. If a period of decoration is to be adopted we should stick to it not only in line, but in colors and material, both woods and woven goods. Some of the periods of decoration which are most pleasing and well adapted for ship interiors are Louis Quatorze, Regency, Louis Quinze, Louis Seize, French Empire, Elizabethan, the Georgian periods, Adams, American Colonial and some others not so well known by those who are not connoisseurs of art. Some of the Italian styles are beautiful and are especially suited for first-class yacht work, as they are fine as to detail, mostly always carved and consequently more costly.

As smoking rooms are mostly always finished in oak, some of the sixteenth century English or Flemish styles always look well and make an agreeable change from the lighter and gayer styles employed for a music room or lounge. For outside rooms, such as a veranda or enclosed promenade deck, palm room and the like, a garden effect with trelliage panels can hardly be improved upon. Stateroom corridors and alcove passages as plain as possible are better than a lot of small panels and fancy moldings. In the stateroom corridors on the Cunard steamer *Aquitania*, panels are eliminated entirely. The walls are built of tongued and grooved planks finished smooth and covered with a light canvas stretched on and painted, with pilasters at doors and corners only. Stateroom division bulkheads, if also built this way, would make all four walls alike in the room. The dead white enameled walls of the average stateroom are too glaring. The flush walls mentioned above would prevent this. We do not need to have carving or ornaments to make a thing attractive. To begin with, carving is a dirt collector, and unless one can afford to have it well executed it had better not be attempted.

Proportion is an important consideration. As the deck heights are usually too low for the size of the room, the walls should be designed to deceive this and give the impression of height. This can be greatly improved by keeping the chair rail, if there be one, as low down as possible, thereby making the upper panels the longest and preventing the squatty look. Columns and pilasters should be well proportioned and with caps and bases suitable for the shafts. Cornices and moldings should have a defined profile. Panels should be large and, when made of several ply wood or one of the many kinds of composition, will not warp or crack. Small panels or those running in a brick fashion have a gingerbread look and require more labor to put together, which adds to the cost and lacks appearance. If a hung type of ceiling be employed—that is, one framed under the deck beams—it should be carefully treated.

There are many difficulties to be dealt with in interior ship decoration, caused by the shape of the vessel, the structure, the crown of the decks, the sheer, the low deck heights and the smallness of the air ports and deck-house windows. The shape of the vessel necessarily has to stand, as well as the structure for the most part. But here many of the difficulties caused by the structure could be avoided if those in charge of the structure and decoration would work together and a little flexibility exercised, together with a little judicious scheming. Stanchions, girder lines and web frames can almost always be placed to suit architectural requirements without sacrificing the strength of the vessel.

The low deck heights, being all out of proportion to the size of the average room, are hard to treat and require resourcefulness unless the public rooms are under the boat deck. If the deck heights will permit it, a good practice is to hang the ceiling under the beams, with large panels and false beams to suit the design of the room. With the hung ceiling it is possible to carry ventilation ducts, pipes, electric wiring, etc., above it and out of sight, to which access can be had where desired by having some of the panels made so that they can be taken down without disturbing the remainder of the work. With a ceiling of this type it can be better treated to suit the period of design chosen for the room and will also serve better to reflect electric lighting by avoiding the deep shadows between the beams.

Air ports and deckhouse windows by the smallness of the openings usually form a problem hard to treat. The inside sash sometimes employed helps matters a great deal. Ports and windows, if worked in pairs, can be treated as a large double window and look better than if spaced singly and equally distanced all around the walls, as so often seen. With the height of large steamers above the water, it is possible to employ large, metal-framed windows especially designed to suit the interior. This is being done on most of the transatlantic lines with great success when the location is not too much exposed to the elements.

Too much care cannot be taken in working out the staircases. The stairs in most vessels are too steep and winding. Winding stairs look attractive only on a plan. 'Thwartship flights should be avoided as much as possible, as in descending such flights one has to meet the rolling motion of the vessel. The proportion of the width of tread to the height of the riser should be carefully worked out. A good rule is to have the sum in inches of one tread and two risers to equal as near as possible to 24 inches, the width of the tread taken always without the nosing. A good proportion would be 7 inches for the risers and 10 inches for the tread. In no case should the tread be more than 12 inches wide or the risers less than 6 inches high. As the staircase in most vessels is generally a principal

feature, care should be taken to have it of a good design, with balusters or grille railing corresponding to the design of the surrounding joiner work.

As artificial lighting has more than ever become a strong decorative feature since the advent of electric lighting, a few remarks here would not be out of place. Soft lighting effects are the cry of the present age and the light bulbs, if covered with globes of the many artistic designs manufactured (keeping in mind, of course, the style of the room), will produce this effect. As a vessel's saloons are rarely high enough to successfully have indirect lighting, the wall bracket can be used to a great advantage. When ornamental glass panels are fitted at the ceiling level of skylights or in dome skylights, the lighting of the room is always greatly improved if lights are fitted behind them. Otherwise the skylight makes a black patch at night and puts the whole middle of the room in shadow. The writer believes that the light should come from the same direction by night as by day.

Data on Hog and Sag of Merchant Vessels

BY T. M. CORNBROOKS

ABSTRACT

In a paper read before this society in 1913, Naval Constructor S. F. Smith presented considerable data showing observations made on three navy colliers built by the Maryland Steel Company, to which were added the data of the two colliers built by the Newport News Company. Since that time two additional colliers have been constructed for the Panama Canal. These colliers are of the same general dimensions as the *Orion* and *Jason,* but of increased deadweight capacity.

The *Ulysses* and *Achilles,* Panama colliers Nos. 1 and 2, are built from the same lines as the *Orion* and *Jason,* but to secure the necessary capacity for coal the machinery was moved aft 15 feet and the 'thwartship coal bunkers reduced 10 feet in length, making the holds 25 feet longer. The contract for these vessels required that they should carry 12,000 tons of cargo, 1,200 tons of bunkers and 105 tons of stores, feed water, crew and effects, on a draft of 28 feet 1 inch. As a matter of fact, they drew 27 feet 8 inches when loaded with the above deadweight.

Following the methods used in securing the data on the previous colliers, we started by establishing a datum line by transit while the vessels were on the stocks and supplemented this by readings taken immediately after launch, when machinery was installed, when in dock, before loading and when fully loaded. When fully loaded the *Ulysses* sagged 2⅛ inches and the *Achilles* 2 1/16 inches from the original datum line, as compared with 3⅞ inches on the *Neptune,* 2 15/16 inches on the *Orion* and 3 3/16 inches in the *Nereus.* The difference in the amount of sag between the *Orion* and *Jason* and *Ulysses* and *Achilles* can probably be accounted for by the better distribution of cargo.

Two curves are shown of the *Achilles,* of the ship completed—i. e., May 10 and 20. These observations were taken under the dates noted to determine the deflection while the forward oil tanks and double bottoms were filled with water as itemized, in preparing for a test of the oil-pumping capacity. The results show considerable hogging effect when compared with the *Ulysses* when completed under date of March 15, which can be accounted for by the different conditions of tank loadings.

In addition to the curves taken on the *Orion* and *Jason,* observations on the *Achilles* were taken for determining the deflection of the hull in way of the forward oil holds, when under hydrostatic test.

Period of Vibration of Steam Vessels

BY WILLIAM GATEWOOD

ABSTRACT

The author was led to investigate this subject by the vibrations which occurred in service on an oil tanker built by the shipyard with which he is connected. This tanker is 460 feet long and is fitted with a quadruple expansion engine installed in the stern, designed to indicate about 2,800 horsepower at 78 revolutions per minute. When running in ballast condition, no vibration was experienced. When loaded, however, longitudinal vibrations in a vertical plane were experienced with the engines turning at revolutions between 72 and 76. These vibrations were of the two-nodal character, and their period corresponded with the revolutions of the main engines. After several trips the pitch of the propeller was increased so that the revolutions in service might be less than 72, and under the altered conditions no vibration was experienced.

In order to investigate the matter more thoroughly, however, observations were taken on the vessel after the pitch of the propeller had been increased. The methods of taking observations were somewhat primitive and consisted of a device for measuring variations in the shape of the vessel in a vertical plane and another device for measuring the change in length of the deck plating.

The observations took place in the Gulf of Mexico in July, 1914, with the vessel loaded with about 11,000 tons, deadweight. The revolutions of the main engine were increased from 68 to 74, when a slight vibration became noticeable. When the revolutions were increased to 76, the vibrations were quite appreciable. The motion amounted to about ½ inch total. It was difficult to determine this with exactness, as it varied slightly, but it never appeared to exceed ¾ inch, and ½ inch seems near the true reading. The number of vibrations corresponded with the revolutions of the engine. The type of vibration was of the two-nodal character, in which the bow and stern drop as the midship portion of the vessel rises, and rise as the midship portion drops. The nodes seemed to lie near the after end of the bridge deck-house and at the after cofferdam, but it was difficult to decide where the nodes were. The variation in stress in the shelter-deck stringer corresponding to 1/16 inch variation in length in 90 feet amounts to about 1,700 pounds per square inch. The deck was already in compression, and the additional compressive stress therefore amounted to about 850 pounds per square inch.

During the tests the sea was smooth. When the engines were slowed down the vibrations ceased. When the revolutions were raised to 76 again, so that indicator cards might be taken, the vibrations reappeared, and of the same intensity as before. Here seemed to be a case of synchronism between the revolutions of the main engine and the period of vibration of the hull structure occurring in the working range of revolutions of the engine on a vessel of low speed.

The Application of Small Steam Turbines for Auxiliary Purposes on Board Ship

BY W. J. A. LONDON AND FREDERICK D. HERBERT

ABSTRACT

In marine work we have seen the gradual elimination of the reciprocating engine for practically all classes of work by the turbine. The turbo-generator has become practically the standard unit for electrical production in all navies and merchant marine, so that little need be said about this application at the present time. The really interesting phase of the small turbine situation to-day,

however, is in the wider application of this machine. The small turbine is now successfully employed for the following purposes: (1) Generator sets, (2) wireless sets, (3) forced draft blowers, (4) circulating pumps, (5) hot well pumps, (6) ash ejectors, (7) induced draft fans, (8) ballast and service pumps.

The three new battleships, the *Arizona, Mississippi* and *Idaho* are being equipped with turbine auxiliaries as follows:

Type.	Arizona.						Mississippi.						Idaho.					
	No.	Steam Press.	Back Press	Speed R.P.M.	B.H.P.	D. C. or Geared.	No.	Steam Press.	Back Press	Speed R.P.M.	B.H.P.	D. C. or Geared.	No.	Steam Press.	Back Press	Speed R.P.M.	B.H.P.	D. C. or Geared
		Lbs.	Lbs.					Lbs.	Lbs.					Lbs.	Lbs.			
Dynamo condenser pumps							2	295	26	1275	15.8	D. C.	2	200	26	1275	14.4	D. C.
	.....	....	.....	....	....	....	3	295	15	3000	144	D. C.	3	230	15	3000	174	D. C.
Boiler feed pumps	2	250	15	3000	180	D. C.	.....	....	.....	....	....	....	9	250	10	1550	46	D. C.
Forced-draft fans	12	250	15	1550	32	D. C.												
Main circulating pumps	.....	....	.....	....	....	....	2	265	20	3620 850	460	Geared	2	230	5	1350	347	D. C.
Distiller circulating pumps	.....	....	.....	....	....	....	2	295	8	2000	13.2	D. C.	2	250	8	2000	12	D. C.

The paper discusses at length the application of the small steam turbine to blowers and pumps and the detail design of small steam turbines. These applications will be taken up in detail in a later issue.

The Maintenance of the Fleet

BY CAPTAIN A. P. NIBLACK, U. S. N.

ABSTRACT

In this paper the author strongly urges the fortification and equipment of island bases in the Pacific Ocean at such points as Guam, Tutuila, Midway and the Aleutian Islands. To show the necessity of such naval bases as auxiliary centers of supply and security, he assumes as an illustration that a United States naval fleet of thirty battleships, twenty cruisers, forty destroyers, twenty colliers, three supply ships and a fleet repair ship is assembled off Panama to make a leisurely voyage to Manila and return by way of Honolulu, Midway and Guam. The margin of fuel supply on these vessels for the successful completion of this voyage, even at slow speed in times of peace, when no bad weather is encountered and there are no delays from breakdowns, is shown to be extremely small. In the event of war, however, the high speed required in scouting and protecting would increase enormously the demand for fuel, and in order to make such a voyage under these conditions, the proposed fortified island naval bases would become a practical necessity.

Superheated Steam in Marine Practice

BY HENRY B. OATLEY

ABSTRACT

The subject is treated under separate headings dealing with superheater development, superheater design and construction, engine conditions with superheated steam, engine operation with superheated steam, equipment necessary for superheated steam operation and difficulties to be overcome and advantages to be gained by using superheated steam. In marine practice during the last fifteen years over 1,200 ships have been fitted with superheaters, all using 150 degrees of superheat and the majority operating with practically 200 degrees superheat. The author does not consider it an exaggeration to state that, at the present time, well over 2,000 steamers are afloat using superheated steam, the majority of which are operating with what can be classed as "high superheat"—that is, above 125 degrees.

In discussing the design and construction of superheaters, three different classes are considered: separately fired superheaters, waste gas superheaters and live gas superheaters. The various types of superheaters coming under these classes which have been used commercially are described and illustrated in detail. In the operation of engines with superheated steam, one of the main considerations is lubrication. The keynote of the lubrication question with highly superheated steam is that a regular supply rather than a large quantity of oil is required. The oil furnishes the lubrication previously afforded by the water present in the saturated steam, but it does not follow that a regular supply of oil means a large quantity of oil. The special equipment required for handling superheated steam includes a lubricating oil pump and pipes, filters, pyrometers and mixing pipes for leading saturated steam to the main steam pipe and superheated steam to the auxiliary steam pipe. In a superheated steam installation the steam pipes, stop valves and feed should contain no copper or brass. Many governmental regulations prohibit cast iron and malleable iron. In any event, the steam pipes and flanges should be well insulated. Steam chest valves on the high-pressure cylinder should be of the piston type with rings wherever the degree of superheat is sufficient to eliminate all condensation through the first cylinder. Engine cylinders and liners must be of first-class, close-grained cast iron as hard as can be worked. The piston rings should be of strong, hard cast iron.

With superheated steam the question of cylinder ratios becomes important. The published dimensions of English and German steamships using superheated steam show that a lower cylinder ratio is used than with saturated steam. This is generally accomplished by increasing the diameter of the high-pressure cylinder, the intermediate- and the low-pressure diameters on a triple expansion engine remaining as before. In converting saturated engines to the use of superheated steam, an increase in the high-pressure cylinder diameter is not always advisable, and many times not possible. In such cases, if the same indicated horsepower is to be obtained, it is necessary to increase the cut-off in the high-pressure cylinder, thus giving an increased volume of steam at the cut-off and in effect decreasing the cylinder ratio.

The recognized advantages for ship owners in using superheated steam are summed up as follows: Fuel and water economy, reduced valve leakage, increased boiler capacity and increased revenue cargo space.

The situation as regards superheaters and the use of highly superheated steam is summed up by stating that designs suitable from the standpoint of efficiency, simplicity, accessibility and durability are available for ship owners. The difficulties which discouraged the earlier designers have been overcome as regards detail designs and operating conditions, and therefore the installation, operation and maintenance of high degree superheaters appear to be not only possible, but practical and beneficial in marine practice.

The Submarine of To-Day and To-Morrow

BY L. Y. SPEAR

Abstract

Owing to the secrecy imposed by war conditions, the number of boats built or building to-day is not definitely known, but the best information available indicates that about 350 have already been completed and that about 200 more are now under construction. The growth of the mechanical development of the submarine may perhaps be best illustrated by a comparison of the characteristics of one of the first successful boats with those of a recent type. The principal characteristics of these two designs designated as "A" and "B" are set forth in Table I:

TABLE I

	Type "A" 1900	Type "B" 1914
Length	53′ 10″	230′ 6″
Beam	10′ 3″	21′ 6″
Surface displacement, tons	67	663
Submerged displacement, tons	75	912
Horsepower, surface	50	2,000
Speed, surface, knots	6	17
Horsepower, submerged	50	980
Speed, submerged, knots	5½	10¾
Radius action, surface, knots	200	3,000
Number torpedo tubes	1	8

The comparative figures given in Table II are of interest as showing the improvement resulting from ten years of step by step development:

TABLE II

	Type "A" 1900	Type "B" 1914
Horsepower main engines	50	2,000
Pounds per horsepower	78	48
Fuel consumption, pounds per horsepower	.74	.50
Horsepower electric motors	50	980
Pounds per horsepower	57	48
Pounds per horsepower of storage battery	909	216

As noted above, type "B," for the design of which the author is responsible, has been selected as fairly representative of the best results actually achieved to date in the mechanical development of the submarine. The representative character of the figures will be corroborated by an examination of the characteristics of the contemporary vessels in the English and German navies, viz., the English "E" class and the German "U-21 to U-32" in Table III, as well as such data as are available with respect to the German class "U-33 to U-42," which have been commissioned since the outbreak of the war.

TABLE III

	Type "B"	English Type "E"	German "U-21 to U-32"	German "U-33 to U-42"
Length	230′ 6″	175′	213′	223′
Surface displacement, tons	663	730	640	665
Submerged displacement, tons	912	825	787	822
Engines	Diesel	Diesel	Diesel	Diesel
Horsepower, surface	2,000	1,600	1,800	2,300
Speed, surface, knots	17	15-16	16	17
Speed, submerged, knots	10¾	9-10	10	10
Armament, torpedo tubes	8	6*	4*	5*
Armament, guns	0	2	2	2

* Doubtful.

Counting, then, only such boats as are actually in active commission and of proved qualities, we may sum up this phase of the subject by saying that from the point of view of mechanical development "the submarine of to-day" connotes a vessel of the following approximate characteristics:

Surface displacement....................650 to 750 tons
Submerged displacement..................800 to 900 tons
Surface horsepower......................1,600 to 2,300
Surface speed...........................15 to 17 knots
Submerged speed.........................9 to 11 knots
Armament..........2 guns of from 3 to 4 inches caliber and 4 to 8 torpedo tubes

The wide radius of action of such boats and their efficiency when operating submerged at long distances from their base have been amply demonstrated in the present war, as in the exploits of the English "E" boats in the Dardanelles, the Baltic and the North Sea, and the similar work of the German boats "U-21 to 41" in the North Sea, the Atlantic and Turkish waters.

Considering the "submarine of to-morrow" from an engineering standpoint, assuming certain speeds, radii and armament as rigid requirements, it is obvious that the displacement must vary according to the type of machinery installed and the amount of attention paid in the design to questions of access and reliability. The most important items in this connection are, of course, the main engines and the storage batteries. In each case reliability and long life are in conflict with compactness and light weight. In these important respects, there is as yet no uniformity of practice in the different navies of the world. In certain continental countries, notably Germany, the extreme of lightness and compactness is sought, accessibility is sacrificed, and a very highly trained personnel is relied on for reliability. The wide range of practice is illustrated by the fact that the weight in pounds per horsepower of the main engines of the single-acting Diesel type almost universally used varies from 50 to 100. In the case of storage batteries, the weight per motor horsepower at the one hour rate of discharge varies from 131 to 253 pounds. The smaller figure represents the extreme case where the durability of the battery is sacrificed to capacity. The heavier of the two batteries is, in fact, expected to have a service life at least three times as great as the lighter.

Quite aside from the type of machinery adopted, the matter of access and roominess in general is of great importance, and finally we must in addition consider the demands made by safety features, including elaborate bulkhead sub-division, as well as the installation of special fittings and appliances, such as submarine signals and the like.

To illustrate the aggregate effect of such considerations, we may compare a comparatively simple design of date of 1910 with a very recent one. The early design has the following characteristics: 1910

Surface speed...............................14 knots
Surface fuel radius.........................2,490 miles
Submerged speed.............................11½ knots
Submerged radius at 5 knots.................110 miles
Armaments...........4 torpedo tubes and 4 torpedoes

Later Design

Surface speed...............................14 knots
Surface fuel radius.........................3,150 miles
Submerged speed.............................10½ knots
Submerged radius at 5 knots.................75 miles
Armaments......4 tubes, 8 torpedoes and one 3-inch gun

It will be noted that the newer design provides for slightly greater armament with an increase in the surface radius. On the other hand, this has been compensated for by a decrease in the submerged speed and radius. Notwithstanding this reduction in submerged qualities, the surface displacement is increased sixty percent. In this particular case, there is no material difference in the weight and space per horsepower of the main engines and the very large increase in displacement has nearly all been absorbed by habitability and safety features.

In addition to the engineering problems involved, the development of the submarine is discussed at length from a military standpoint and the probabilities are considered with respect to the characteristics of the United States submarines of the near future, both for coast defense and for fleet service.

New Marine Refrigerating Machine

Description of Construction and Operation of Westinghouse-Leblanc Refrigerating Machine Designed for Marine Work

BY G. L. KOTHNY*

On Friday, October 29, a public demonstration of a new type of refrigerating machine especially suitable for marine installations was given at the Westinghouse Machine Company's works at East Pittsburgh, Pa., in the presence of some prominent naval men and shipbuilders.

The machine tested is known as the Westinghouse-Leblanc refrigerating machine, which uses water as a cooling medium and produces cold by direct partial evaporation of water from the brine passing through the machine, and thus cooling the same. Water has always been known as an ideal cooling medium. It is universally available, it is neither difficult nor dangerous to handle, and the ratio between its latent heat and the heat of the liquid is, as shown in Table 1, much higher than that of any other cooling medium.

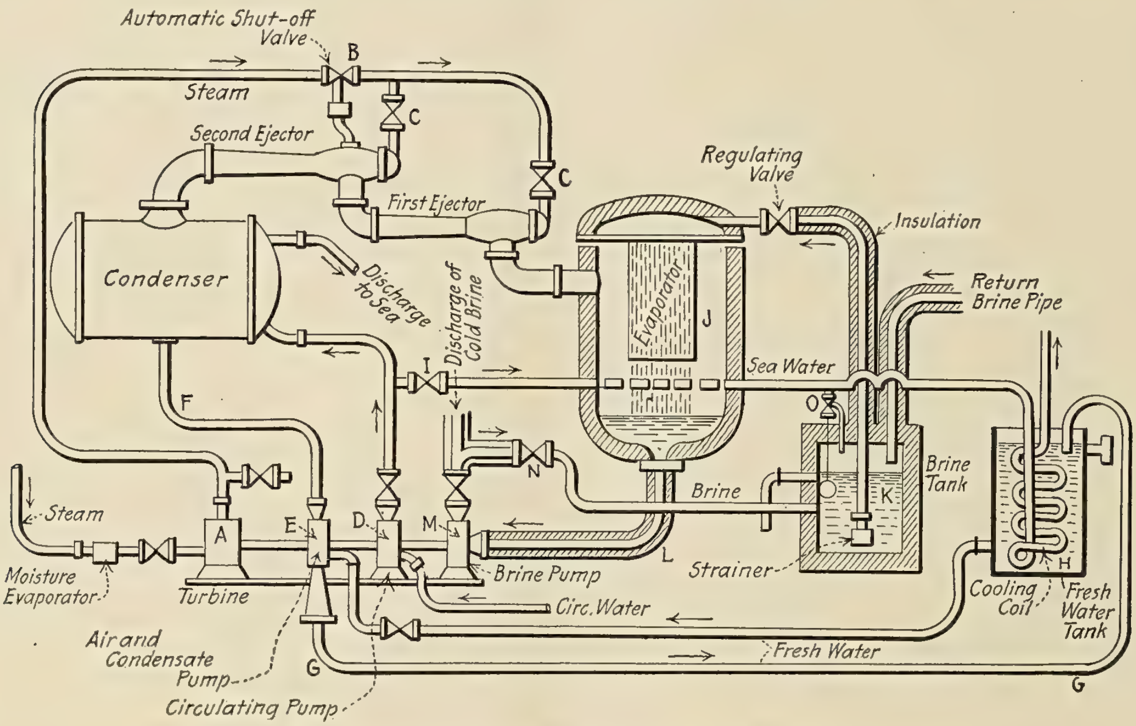


Fig. 1.—Diagrammatic Arrangement of Westinghouse-Leblanc Refrigerating Machine

TABLE NO. 1—LATENT AND SENSIBLE HEAT OF ONE POUND OF DIFFERENT LIQUIDS FOR 14 DEG. F. LIQUID TEMPERATURE AND 68 DEG. F. CONDENSER TEMPERATURE

	Ammonia NH_3	Carbon Dioxide CO_2	Sulphur Dioxide SO_2	Water H_2O
Pressure in brine cooler, lbs. per sq. in.	41.5	385.0	14.6	0.0398
Condenser pressure, lbs. per sq. in.	125.0	825.0	76.0	0.3270
Latent heat, in B. T. U.	558.0	111.0	172.0	1050.0000
Heat of liquid, in B. T. U.	51.0	32.0	17.4	54.0000
Heat units available for producing cold, per lb.	507.0	79.0	155.6	996.0000
Percent, taking water as a base	51.0	7.9	15.7	100.0000

The evaporation of water in the Westinghouse-Leblanc machine is obtained by producing and maintaining a vacuum, which corresponds to the vapor tension of the water at the desired brine temperature, in an evaporator through which the brine circulates. In other words, if, for instance, it is desired to produce brine at 14 degrees F. temperature, a vacuum corresponding to the vapor tension of water at 14 degrees F. (which is 0.08 inch Hg. absolute), or of 29.92-inch Hg. with 30-inch barometer, has to be produced and maintained in the evaporator, the vessel through which the brine circulates and in which it is cooled.

In the Westinghouse-Leblanc machine this is accomplished by a combination of steam ejector or ejectors and condensing plant, the ejector or ejectors producing the difference in vacuum between that necessary in the evaporator and the highest possible vacuum which may be obtained in the condenser with circulating water of a certain given temperature. A diagrammatic arrangement is shown in Fig. 1. The operation is as follows:

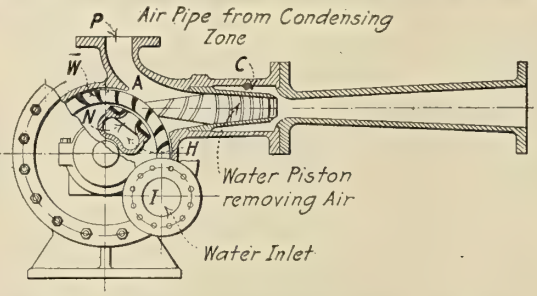


Fig. 2.—Section of Westinghouse-Leblanc Air Pump

Live steam enters the steam turbine (*A*) after passing

* Engineer, the Westinghouse Machine Company, East Pittsburg, Pa.

through a moisture evaporator with a steam pressure of about 200 pounds gage, and develops the necessary energy in the turbine for driving the pumps, which are coupled directly to the turbine. The steam leaves the turbine with a back pressure of about 55 pounds and passes through the automatic shut-off valve *B* and the steam globe valves *C-C* to the steam ejectors (marked first and second ejector). The object of the automatic shut-off valve is to prevent steam from entering the ejectors as long as there is no vacuum in the evaporator or condenser. The valve itself is controlled by vacuum and will not operate unless a designed vacuum exists in the condenser.

The high vacuum in the evaporator is produced and maintained by the two steam ejectors, working in conjunction with a surface condensing plant. The surface condensing plant consists of a surface condenser, condenser circulating pump (*D*) and Leblanc air and condensate pump (*E*). Circulating water enters the circulating pump, passes through the pump, which is of the centrifugal type and also through a non-return valve, then through a pipe as indicated by the arrows into the condenser, and is finally discharged back to the sea. The air and condensed steam are taken out from the condenser through pipe *F* and removed by the air pump *E*, which is of the rotary hydraulic type, through pipe *G* into the fresh-water tank *H*.

A cross-sectional view of the Westinghouse-Leblanc air pump is shown in Fig. 2. The principle of operation is illustrated in this figure. Water enters the chamber *H* through the opening *I* and flows out through the orifice *N*. The impeller *W*, rotating in a clockwise direction, cuts off layers of water and projects them into the cone *C*. Between the successive pistons of water, layers of air drawn in through opening *P* are imprisoned. The high velocity of these water pistons is transformed into pressure by means of the diffusing cone so the moisture may be discharged against atmospheric or somewhat higher pressure.

It is obvious that the temperature of water in tank *H* (Fig. 1) would gradually increase, due to the continual addition of the heat contained in the condensed steam. As it is essential that cold water should be used in the air pump, a cooling coil is placed in the air pump water tank and a portion of the discharge from the circulating pump *D* regulated by valve *I* is passed through the coil.

The ejectors are operated by the exhaust steam of the turbine and are arranged in series. The first ejector removes the vapors from the evaporator *J*, thereby maintaining inside of the evaporator an absolute pressure corresponding to the vapor tension of the brine temperature and compresses the same to a higher absolute pressure, which is produced and maintained by the second ejector. The second ejector compresses the vapors plus the live steam used in the first ejector to the absolute pressure obtained in the surface condenser, thereby delivering those to the condenser, wherein vapors and steam are condensed and removed by the Leblanc air pump *E*.

The ejectors are of convergent divergent shape and have multiple steam nozzles, which are arranged in ranges, the outer ones overlapping the inner ones. Fig. 3 shows a sectional view of one of the ejectors, and Fig. 4 shows a typical photograph of the arrangement of the steam nozzles.

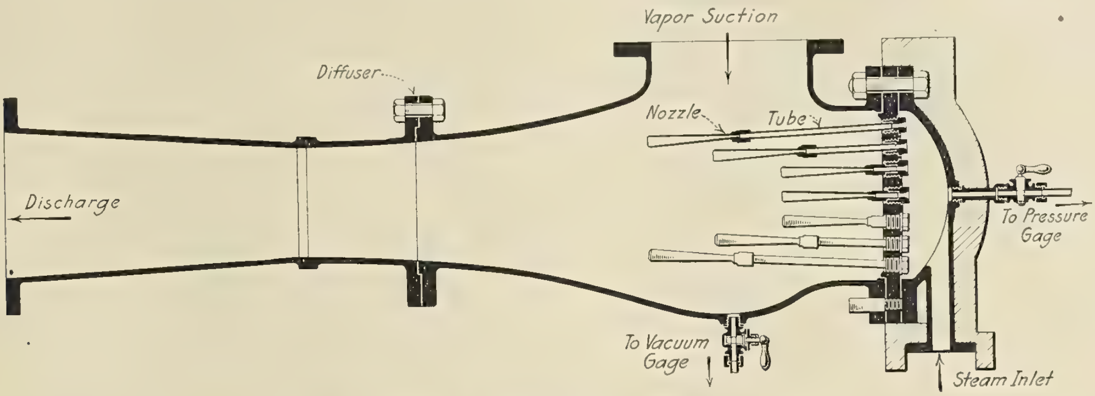


Fig. 3.—Section of Westinghouse-Leblanc Steam Ejector

The circulation of the brine is as follows: By the high vacuum existing in the evaporator *J*, brine is drawn into the evaporator from the brine tank *K*, passing through a strainer in the bottom of the tank and then through the vertical pipe and through a regulating valve before entering the top of the evaporator. Inside the evaporator a section through which is shown in Fig. 5, it is distributed through small orifices and falls down in the form of a fine spray or rain. While falling down, a part of this brine is evaporated and the remaining brine is cooled down and taken out through pipe *L* by the brine pump *M*. After leaving the pump it passes through a non-return valve and into the pipe which carries the cold brine to the place where it is to be used—that is, either to the ice-making tank or cold storage rooms. Thence the brine returns to the brine tank *K* through the return pipe and is recirculated as already described.

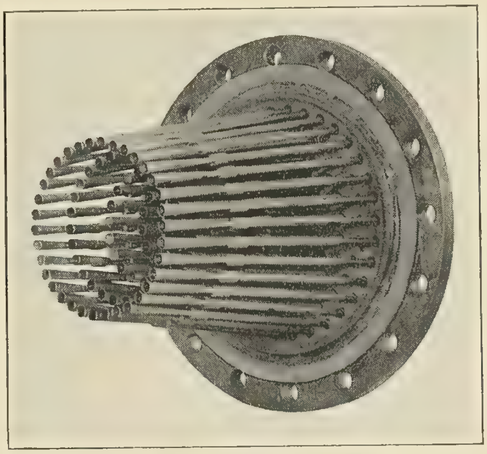


Fig. 4.—Ejector Nozzles

An automatic brine pressure relief valve *N* is provided at the discharge of the brine pump and the outlet of this valve is connected directly to the brine tank *K*. The object of this valve is to allow the brine to return automatically to the brine tank in case all the valves in the

brine system (which may be located far away from the machine) are accidentally closed and thus prevent the discharge of brine from the pump, which would result in the filling up of the evaporator. Fig. 6 shows a section through this valve which may be adjusted to operate at any specified pressure.

A certain amount of water corresponding to the B. T. U.'s output of the machine is evaporated while the brine passes through the evaporator, and this has to be added again to prevent the brine from becoming more and more dense. This is automatically done by the make-up valve *O*, which opens whenever the brine level in the brine tank lowers and allows some sea water to flow into the brine tank until the normal brine level is reached.

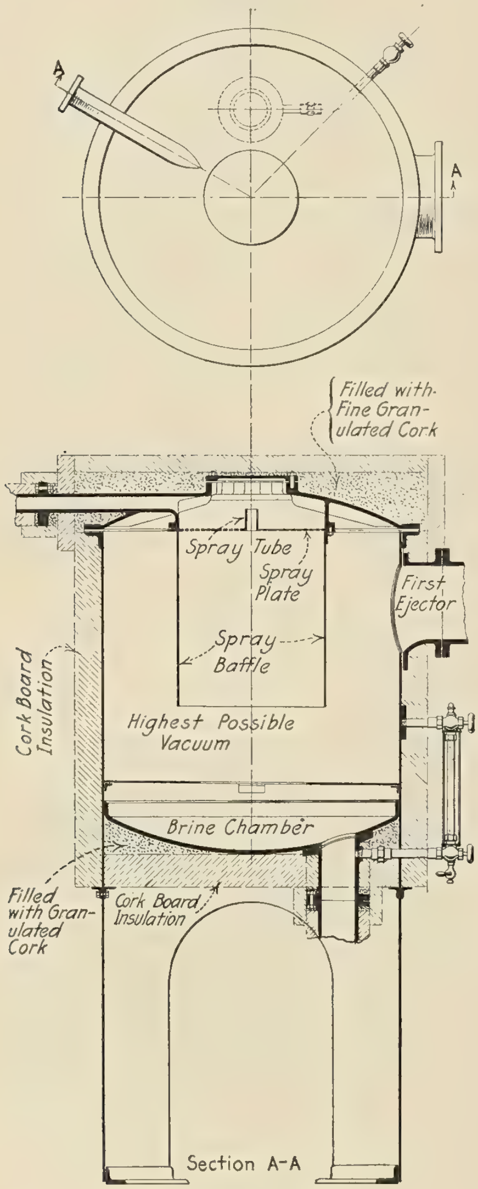


Fig. 5.—Evaporator

A section through the driving steam turbine, the circulating, air and brine pumps is shown in Fig. 7. The turbine is of the single-wheel impulse type and has an automatic stop governor which prevents the turbine and pumps from running at an undesirable speed. As all of the pumps are of the centrifugal type, and two of them are always submerged, there is no necessity to provide a speed regulating governor. All the pumps have automatically water or brine sealed glands which insure their being air tight.

Fig. 8 shows a section through the surface condenser. The condenser is of the four-pass type and has ⅝ inch O. D. tubes, No. 18 B. W. G.; the air suction is arranged on the side of the condenser, while the condensate outlet is located at the bottom.

Fig. 9 shows the arrangement and also illustrates the operation of the automatic shut-off valve *B* (Fig. 1). A flexible diaphragm reinforced by a steel plate and held upwards by a spring forms the top cover of a small cylinder which is connected to the surface condenser. When the vacuum reaches a certain point, the atmospheric pressure will overcome the compression of the spring and move the trip rod downwards. If the trigger operating the steam valve is now pressed down, the catcher on the trigger will be caught by the trip rod and the valve will be held open. As soon as the vacuum drops to a point where the atmospheric pressure does not any more overcome the compression of the spring underneath the diaphragm, the trip rod will be lifted and the trigger will be released, thereby closing the steam valve.

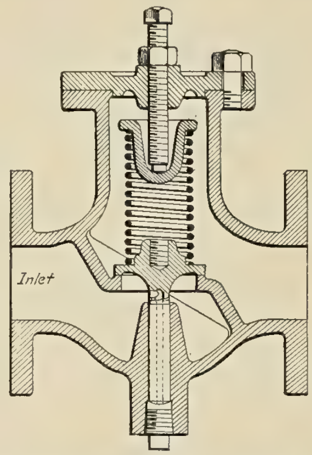


Fig. 6.—Section of Brine Relief Valve

An outline of the complete machine as described is shown in Fig. 10, while Fig. 11 shows a photograph of the same machine. Referring to Fig. 11, the pumps and their driving turbine will be seen at the bottom of the picture, the circulating pump being at the extreme left, followed by the steam turbine, which is lagged and covered; next to it is the Leblanc air pump, on top of which the air and condensate suction pipe is seen, and finally on the extreme right is the brine pump, which is insulated with cork.

The machine demonstrated was used for making ice and the cold brine discharge was connected to an ice-making tank (Fig. 12) of a design suitable for marine service. The tank holds 9 U. S. Standard ice cans. Each can has a steel brace riveted around the top, which also holds a rubber packing where this brace comes into contact with the cover plate of the tank. The ice cans are held down to the cast iron cover plate by semi-circular wedges, which are operated by a spanner or wrench. The cans are thus held tight against the tank, which prevents any splashing of brine when the ship is rolling. The brine surrounding the cans inside of the tank is cooled and kept at an equal temperature by a rectangular cooling coil located inside the tank close to its outer walls through which the cold brine discharged from the refrigerating machine passes. The ice cans are covered with wooden lids, which prevent any splashing of fresh water when the cans are filled up at the beginning of the process of freezing. The circulating brine inlet and outlet will be seen on the right-hand side.

A capacity test of this machine was made previous to

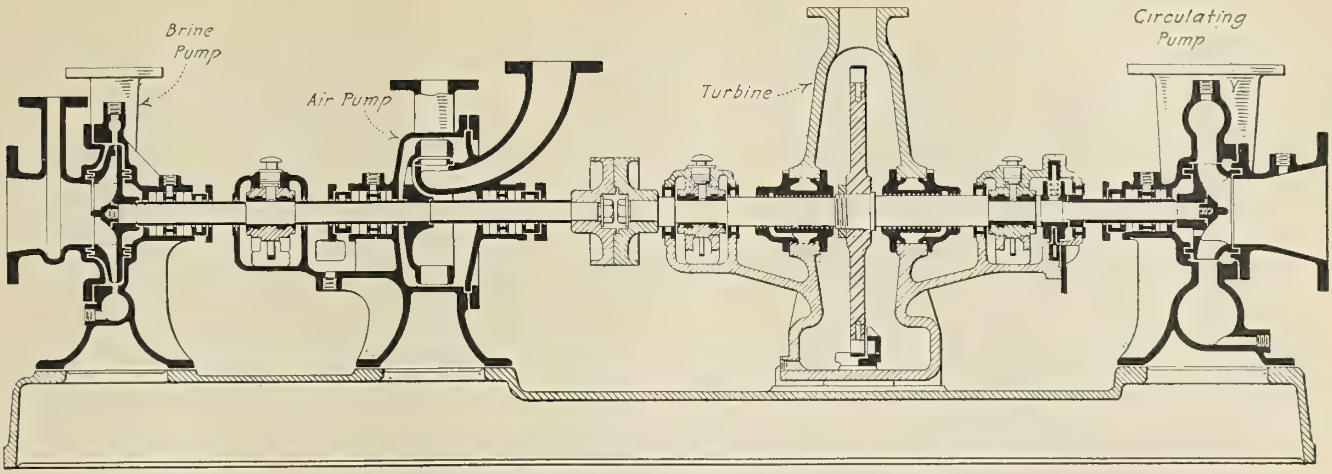


Fig. 7.—Section Through Turbine, Brine, Air and Circulating Pumps

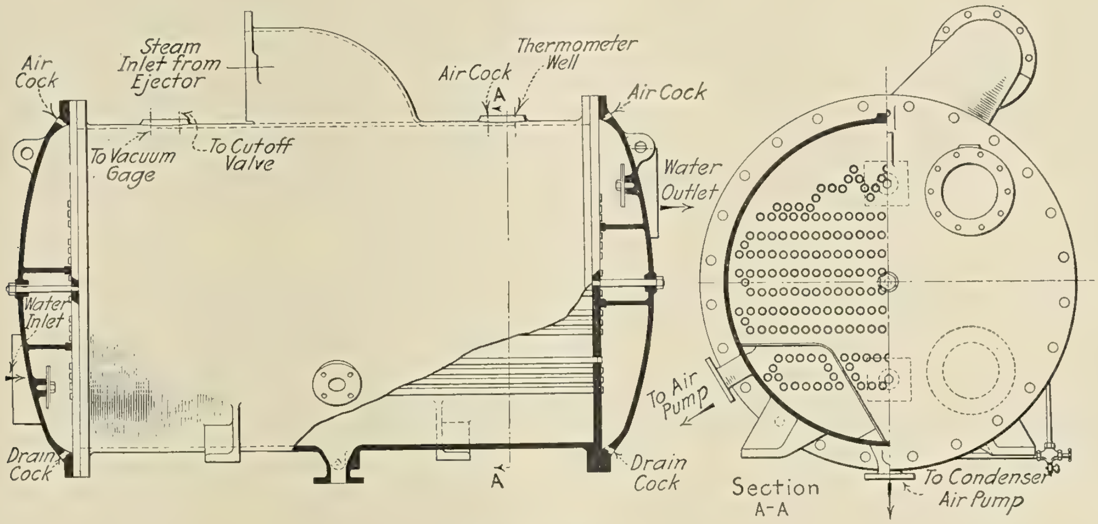


Fig. 8.—Condenser

the demonstrating test. In carrying out this test, the machine was used for making ice in the marine type ice

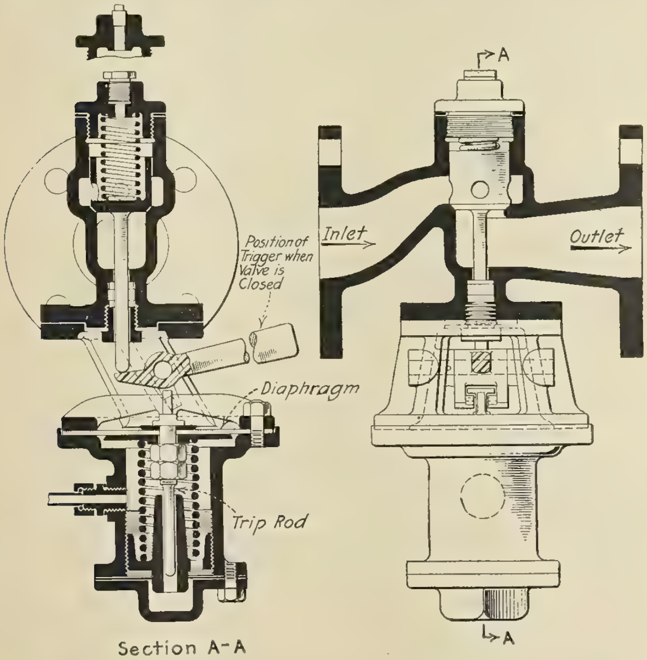


Fig. 9.—Sections Through Automatic Steam Shut-Off Valve

tank, but as the cold required by this tank was less than that produced by the machine, a heating device for heating up the brine was arranged in order to dissipate the total cold produced by the machine. The machine was designed for three tons of refrigeration per day for the following working conditions: Maximum temperature circulating water inlet, 85 degrees F.; brine temperature at discharge of brine pump, 10 degrees F.; live steam pressure, 200 pounds gage; total steam consumption, 955 pounds.

The results obtained with the different brine temperatures are given in Table No. 2. All of the figures represent at least ten independent readings, during which the temperature of the brine at the discharge was maintained practically constant. Referring to this table, it will be noted that the capacity of the machine increases considerably with the increase of the brine temperature. For instance, with a brine temperature of 30 degrees at the discharge the capacity is 8.6 tons of refrigeration. With 10 degrees at the discharge, the capacity is 4.5 tons of refrigeration per day, which is about 50 percent in excess of the designed capacity, which may be considered as a very satisfactory performance.

For higher brine temperatures it will not be necessary to use two ejectors in series. One ejector will do the compression work and naturally the steam consumption of this ejector will become considerably less than that of two ejectors. The pumps may also be motor driven if more convenient.

The advantages of this refrigerating machine may be summarized as follows:

The Complete Absence of Chemicals or Compressed Gases.—This is considered of great importance for navy work, as it makes ships using this type of machine naturally independent of the supply of chemicals. They do not need to carry a supply of flasks containing gases at a high pressure, which are a source of danger to the vessel itself, nor will the lack of chemicals interfere with the refrigeration. They can produce refrigeration as long as there is coal available on board to make steam. For a warship this is a most important consideration. In times of war is might be impossible for the vessel to obtain a supply of chemicals, making it necessary to discontinue refrigeration, thereby spoiling the foodstuff in tropical or semi-tropical climates. The powder and ammunition magazines may also be endangered, as some powders or explosives, unless properly cooled, deteriorate and explode from self-combustion. Furthermore, flasks containing gas under pressures of 600 to 1,000 pounds per square inch, if struck by one of the enemy's projectiles, would cause as much damage to the ship as the explosion of the projectile

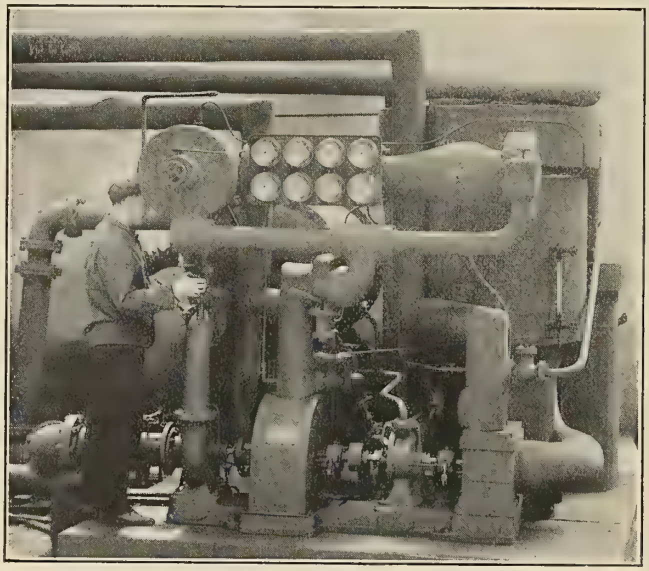


Fig. 11.—Refrigerating Machine Under Test at Westinghouse Works

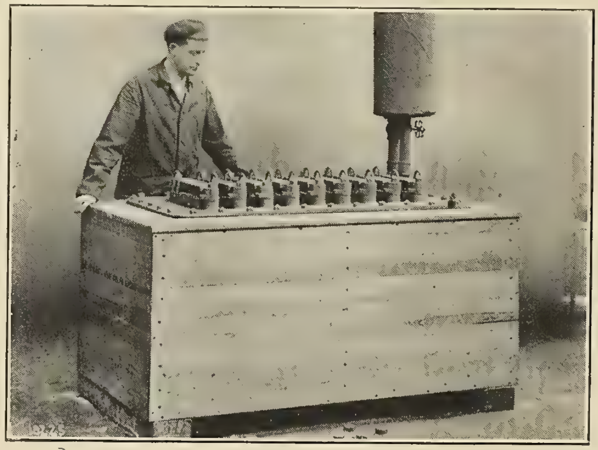
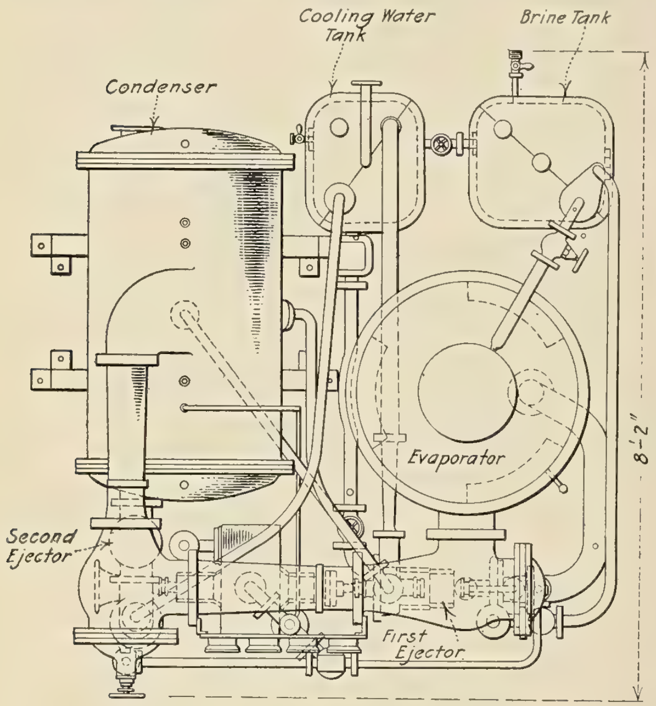
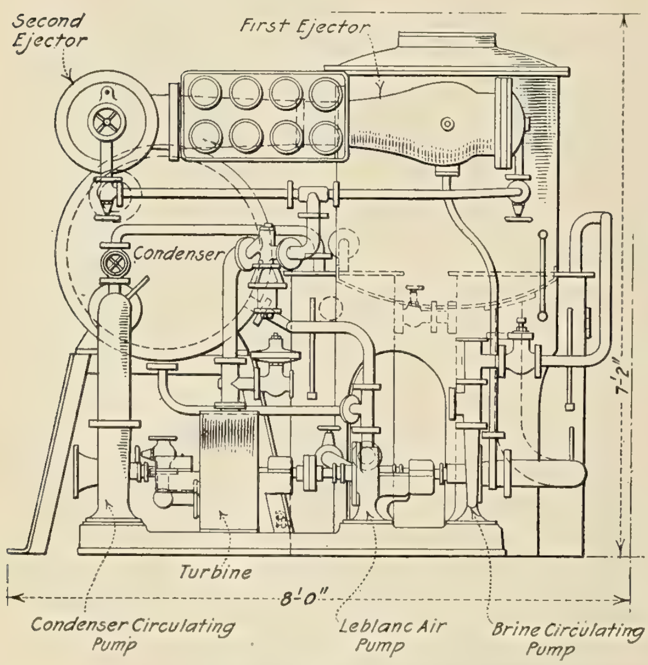


Fig. 12.—Marine Type Ice-Making Tank





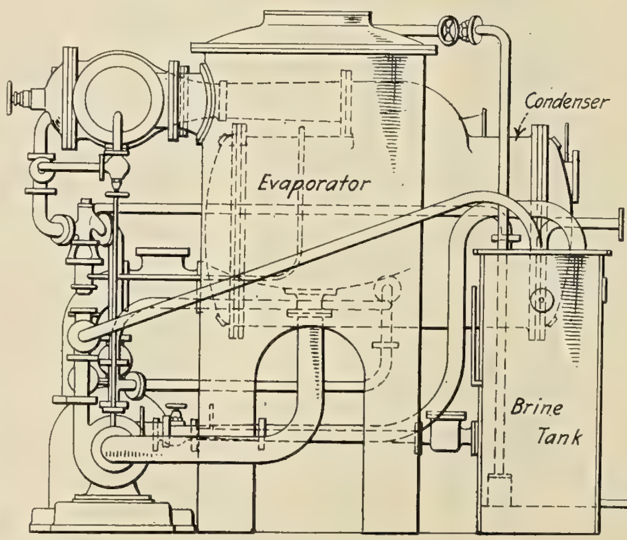


Fig. 10.—Outline of Refrigerating Machine, Showing Plan and Front and Side Elevations

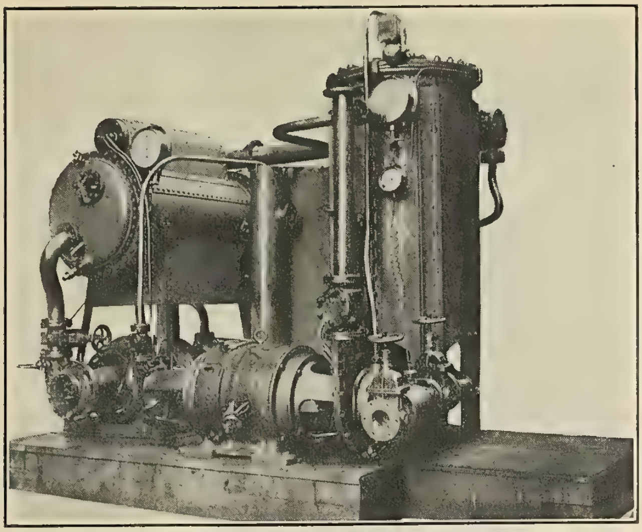


Fig. 13.—Motor-Driven Refrigerating Machine Used in the French Navy

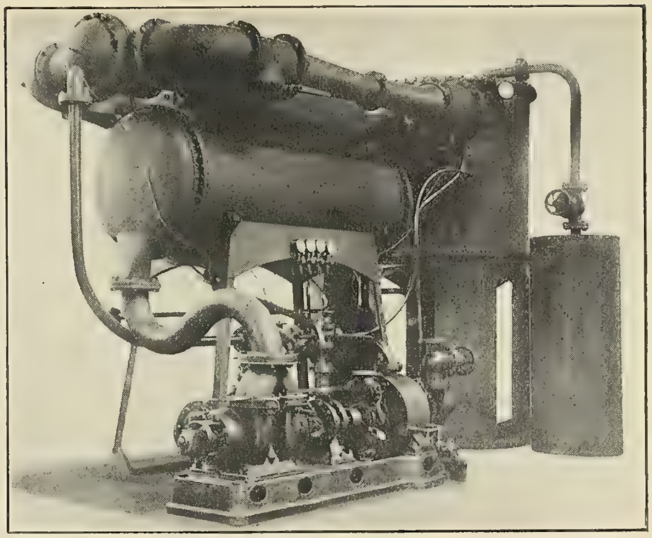


Fig. 14.—Turbine-Driven Refrigerating Machine on Board S. S. *André Lebon*

itself. In the machine described above no gases are used and no pressures have to be maintained. The highest pressure is atmospheric pressure and the cooling medium used are water vapors.

Minimum Weight and Space Occupied.—This is mostly due to the absence of high-pressures inside the machine and also to the direct cooling of the brine. The construction can be very light and at the same time rigid enough to stand atmospheric pressure. It is claimed that the weight of this machine and the space occupied by it are only one-third or one-half that of other types.

Simple Operation.—All of the pumps are of the centrifugal pump type, and form a single revolving element without close clearances. There are no valves to be kept tight, no piston rods to pack and no parts to adjust. The operation is practically automatic and requires no specially trained engineers. The running is silent, a point of particular importance where the apparatus is used on passenger steamers.

Low Cost of Operation and Maintenance.—The reason for this is obvious, when the simplicity of the apparatus is considered. Practically no repairs are needed, there are no chemicals and no high-pressures to handle.

Efficiency.—Tests have shown that the results compare very favorably with those of other types, especially when the inlet temperature of the circulating water is around 85 degrees F.

Brine Coolers Eliminated.—Most of the other types of machines use a brine cooler, which forms a considerable item in weight and space on board the ship. In this machine the brine is cooled directly in the evaporator, and therefore does not require any separate brine cooler.

These many advantages have induced the navies and many of the steamship companies of France, Russia, Austria, Germany, England, Japan, Spain, Greece and Argentine to use this machine on their vessels for ice making, cold storage and magazine cooling. Up to June, 1914, about 250 machines had been installed and ordered in these different countries for marine work, some of them having been in service for over three years, giving excellent results without interruption in service or ever being subjected to any repairs.

A photograph of the type of machine used in the French Navy is shown in Fig. 13. The machine illustrated is of 8 tons refrigeration capacity and is motor driven. Fig. 14 shows a 10-ton turbine-driven machine. Several of these have been installed on the following steamers: *Andre Lebon, Athos, Porthos, Sphinx* of the Compagnie des Messayeries Maritinies, Marseilles, France. These steamers ply between Marseilles, France, and Yokohama, Japan,

TABLE NO. 2.—TEST RESULTS (WESTINGHOUSE-LEBLANC) OF NAVY TYPE REFRIGERATING MACHINE. TESTED AUG. 4 AND 5, 1915. LIVE STEAM, 200 LBS./IN². BAROMETER 29.17 INS. HG. TEMP. OF ATMOSPHERE, 85° TO 87° F.

Vacuum, Inches of Mercury.			Circulating Water Temperature.		Brine.						Refrigeration.				Steam Consumption.		
					Temperature.			Quantity.									
1st Ejector.	2nd Ejector	Condenser.	Inlet to Condenser.	Within Fresh-Water Tank.	Inlet.	Discharge.	Difference.	Pounds Per Hour.	Density Salometer.	Spec. Heat.	B.t.u. Per Hour.	Tons Per Day.	Loss Through Frosted Surface Tons Per Day.	Total Tons.	Steam and Vapor Per Hour.	Vapor Per Hour.	Total Steam Consumed by Turbine and Ejectors.
28.95	28.95	27.35	86.	95	35.50	30.05	5.45	19,080	76	.834	99,598	8.30	0.32	8.62	1,276	106	1,170
28.95	28.95	27.35	85.5	94	27.00	22.80	4.20	19,080	80	.829	76,702	6.39	0.35	6.74	1,276	82	1,194
29.00	28.95	27.80	82.5	92	18.40	15.00	3.40	17,240	77	.833	56,202	4.68	0.37	5.05	1,125	61	1,064
29.00	28.95	27.80	83.0	92	13.00	10.00	3.00	17,240	80	.829	49,479	4.13	0.42	4.55	1,102	53	1,049
29.00	28.95	27.60	86.0	94	13.15	10.10	3.05	17,240	80	.829	50,341	4.20	0.42	4.62	1,042	54	988
29.00	28.95	27.60	84.0	93	11.85	8.90	2.95	16,800	80	.829	47,544	3.96	0.45	4.41	975	52	923
29.00	28.95	27.60	84.5	94	12.80	9.80	3.00	17,240	80	.829	49,479	4.13	0.42	4.55	1,013	53	960

The loss of refrigeration through frosted surfaces is based on 21 ft.³ actually measured. Above readings are the averages of 10 independent readings for each temperature range, taken at intervals of 10 minutes.

passing through the Red Sea, the Indian Ocean and the South China Sea. In those waters the temperature of the circulating water often reaches 90 degrees F., and in spite of this severe condition the machines installed have successfully met all specifications under test.

The Westinghouse Machine Company, of East Pittsburgh, Pa., who are the sole licensees of the Leblanc patents in the United States, have recently taken up the manufacture of this machine for marine as well as for land installations.

New Vacuum Apparatus

Westinghouse-Leblanc Air-Ejector System for Producing High Vacuum

BY G. L. KOTHNY*

On the occasion of the demonstration of tests of a new type of refrigerating machine at the Westinghouse Machine Company's works at East Pittsburgh, Pa., which is described on another page in this issue, a new high-vacuum producing device was also shown to the visitors.

This device is called the Westinghouse-Leblanc air-ejector system. It is a substitute for the ordinary reciprocating vacuum pump, or any other vacuum pump of hydraulic or rotary-piston type, and is designed to produce a very high vacuum in the condenser. The air and non-condensable gases are taken out of the condenser by an air ejector of special design operated by live steam, and the condensed steam is removed from the condenser by a turbine-driven condensate pump of the centrifugal type. A diagrammatic arrangement of this Westinghouse-Leblanc air-ejector system is shown in Fig. 1.

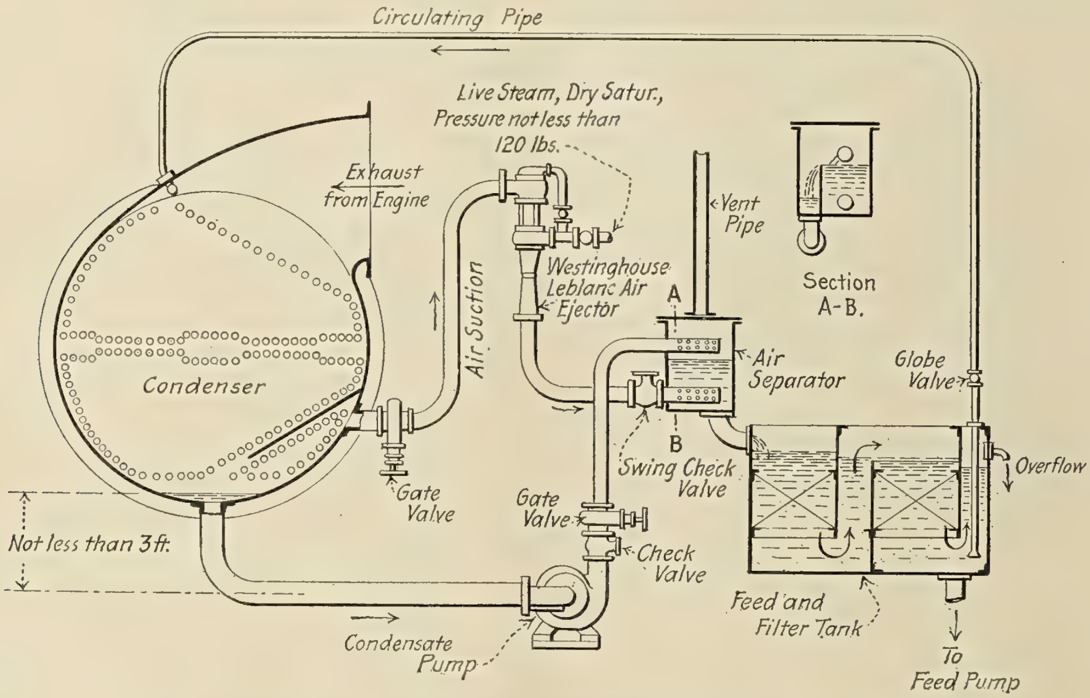


Fig. 1.—Diagrammatic Arrangement of Westinghouse-Leblanc Air Ejector System

Referring to this figure, the operation is as follows: Live steam of any pressure available from the boilers enters the ejector, which acts as a dry vacuum pump, and withdraws the air from the condenser, thereby creating a high vacuum in the same. The condensate, which collects at the bottom of the main condenser, is taken out by the condensate pump and discharged into an air-separating tank, where the steam and vapor coming from the air ejector are condensed by the condensate discharged from the condensate pump. The temperature of the condensate is naturally increased by the heat given to it from the steam discharged from the air ejector. The non-condensable gases and the air removed from the condenser are separated in this tank and escape to the atmosphere through a vent pipe which is arranged on top of the tank. The condensate flows by gravity to the feed and filter tank, from which it is taken by the boiler feed pumps into the boilers. As will easily be seen, the apparatus has the highest thermal efficiency possible, as all the heat supplied is regained in the feed water.

The condensate pump is of the centrifugal type and of special design to operate with a low submergency on the suction side, in order to avoid a high location of the condenser. It is driven by a small steam turbine, the shaft of the turbine being extended to bear the impeller of the pump, which has a single inlet, thus requiring only one gland. This gland is automatically water sealed, thus insuring air tightness. Fig. 2 shows such a pump, having a capacity of 130,000 pounds of steam per hour when

* Engineer, the Westinghouse Machine Company, East Pittsburg, Pa.

working with 12-inch submergency against a total head of 65 feet. It will be noted that the size of the pump is very small, considering its working conditions. The weight of the complete pump, turbine and bed-plate is 750 pounds.

The air ejector is shown in Fig. 3, and a section and further details of this are given on page 551. Two ejectors as illustrated are sufficient for a condensing plant condensing 100,000 pounds of steam per hour, when maintaining a vacuum of 28½ inches with 60 degrees of circulating water. The length of the ejector shown is 3 feet and its weight is 97 pounds.

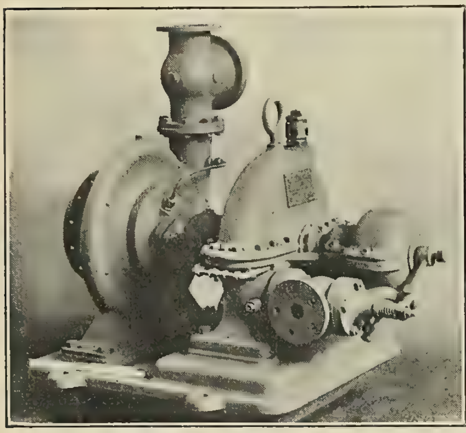


Fig. 2.—Condensate Pump

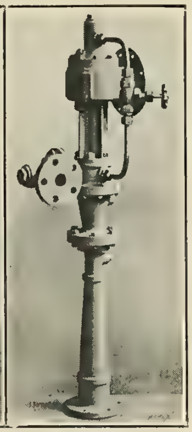


Fig. 3.—Air Ejector

Referring back to Fig. 1, a circulating pipe will be seen connecting the main condenser with the feed-water tank. The purpose of this pipe is explained by the following: It might occur sometimes that the main engines are stopped and that very little steam is entering the main condenser from the auxiliaries, so that there is a very small quantity of condensate to be removed from the condenser. If at the same time the vacuum is to be maintained in the condenser the steam coming from the air ejector would have very little water to be condensed with and the continuous adding of heat by the steam from the ejector may heat up the feed water to an undesirably high temperature. To avoid this and to enable a desired tem-

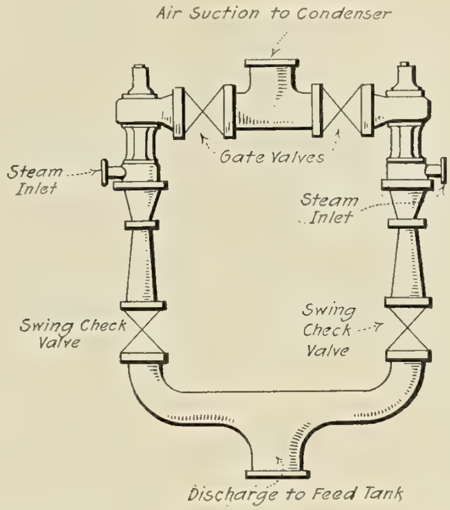


Fig. 4.—Arrangement of Two Air Ejectors in Parallel

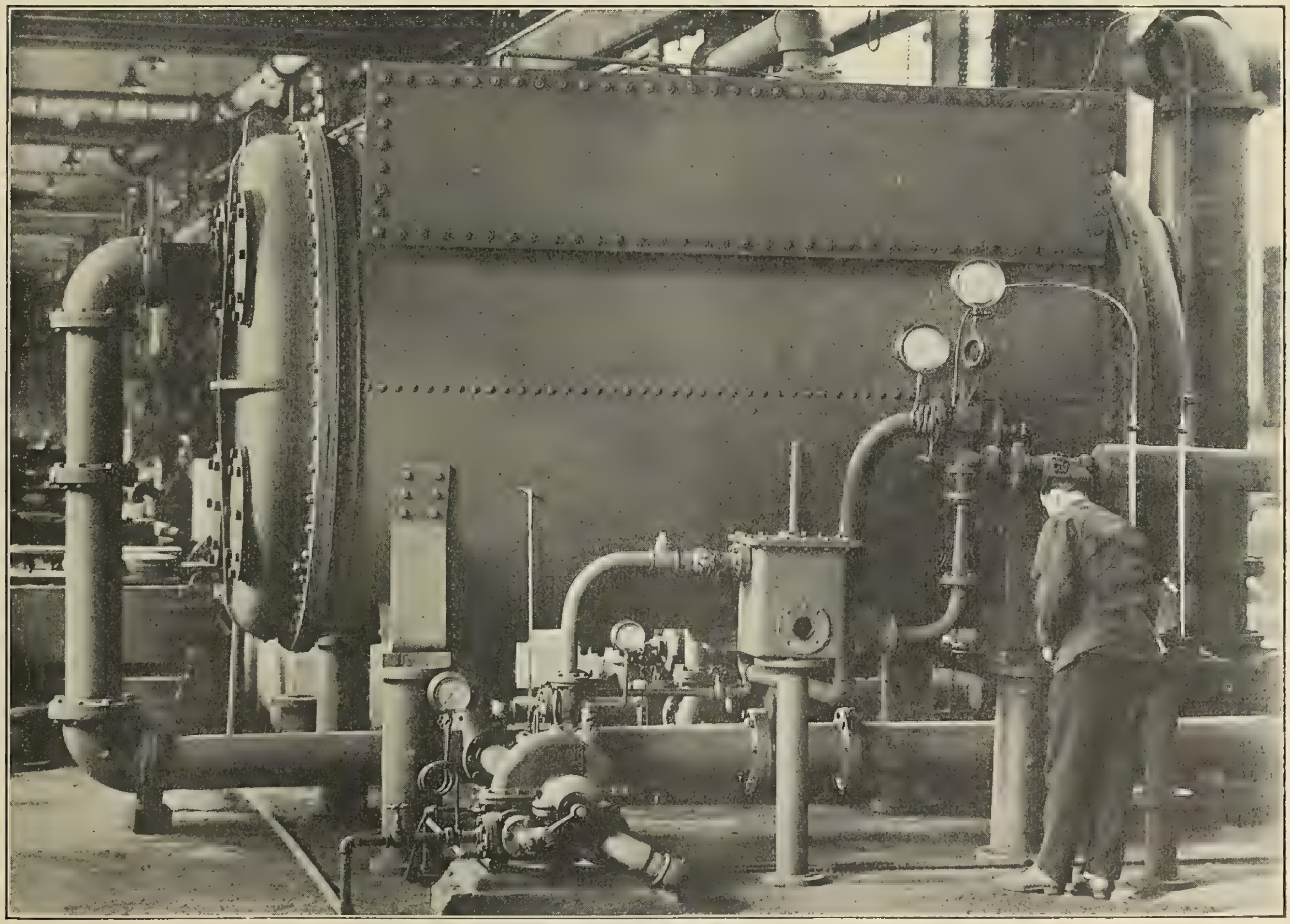


Fig. 5.—Air Ejector Installation at the Westinghouse Machine Company's Works

perature to be maintained in the feed tank, the circulating pipe is provided.

By opening the valve shown in this pipe, hot water from the feed tank is sucked into the condenser by the vacuum, and, while falling over the cold condenser tubes, it is cooled. The cooled water is taken out by the condensate pump and discharged into the air separating tank, where it condenses the steam coming from the air ejector and from where it flows to the feed tank. Part of this water is returned to the condenser and recirculated as described. By regulating the quantity of water returned to the condenser, the temperature of the feed water in the feed tank may be regulated. If, however, a number of auxiliaries are operated while the main engine is idle, the exhaust from the auxiliaries may enter the main condenser and sufficient water will be taken out by the condensate pump for condensing the steam coming from the air ejectors.

Instead of using one ejector, two or three of a smaller size may be arranged in parallel for one condenser, thus allowing one or two ejectors to be shut down (thereby saving one-half or one-third of the steam consumption) when running at low speed or during the cold season, when the vacuum is higher on account of the low temperature of the circulating water. Fig. 4 shows a diagrammatic arrangement of two ejectors in parallel. Gate valves have to be provided at the air suction. The gate valve on the ejector which is not in operation should be closed in order to prevent the atmospheric air from passing through this ejector back into the condenser.

Fig. 5 shows an air-ejector installation at the Westinghouse Machine Company's works at East Pittsburgh, Pa. At the bottom of this picture and to the extreme left the turbine-driven condensate pump is shown. Next to it is the air-separating tank, and at the right-hand side the air ejector.

An installation of this kind has also been made on the United States torpedo boat tender *Melville*, built by the New York Shipbuilding Company, Camden, N. J. The air-ejector system was installed in parallel with the already existing reciprocating air pump and vacuum augmentor, in order to enable a true comparison of both systems under absolutely identical conditions. The performance of the air-ejector system on the *Melville* has been very successful; the vacuum obtained was higher, with less steam consumption than that obtained by the augmentor. A higher feed-water temperature was also obtained and the weight and space occupied by it are considerably less than that of the augmentor system.

The advantages of this new device may be summarized as follows:

Minimum Weight.—A few figures will illustrate this. Taking for example the installation of the main air pump for one main condenser on a battleship: The size of such a pump is 18 inches by 36 inches by 36 inches by 27 inches; its weight about 15,000 pounds. To this would have to be added the weight of the augmentor, the augmentor condenser, the water seal and the inter-connecting piping between the different parts of the augmentor installation, which is about 5,500 pounds, the total weight of one complete air pump installation with augmentor being 20,500 pounds without water.

The Westinghouse-Leblanc air-ejector installation would weigh as follows:

Air ejectors	650 pounds
Condensate pump, turbine and bed-plate	1,000 "
Valves, accessories and air-separating tank	920 "
Total weight of installation	2,570 pounds

against 20,500 pounds of the reciprocating-pump installation, or the air-ejector installation weighs only about one-eighth of the reciprocating-pump installation. This does not include the difference in weight of the piping, the sizes of which are considerably larger for the reciprocating-pump installation, and when filled with water will be considerably greater in weight.

Minimum Space.—The space occupied by the Leblanc air-ejector system is from one-eighth to one-tenth that of the reciprocating-pump installation. Furthermore, the air ejector has the advantage that it may be located anywhere, just like a piece of pipe, and also does not need to be in a certain relative position to the main condenser or to the condensate pump. The reciprocating pump and the vacuum augmentor, augmentor condenser and water seal, however, must always be arranged in a relative position to each other, which makes the general arrangement of the augmentor installation difficult and complicated.

High Thermal Efficiency.—All steam used in the air ejector and the turbine driving the condensate pump is condensed by the condensed steam from the main condenser. The temperature of the condensate is raised by the heat contained in the steam of the air ejectors and the turbine, while in the augmentor system the heat contained in the steam operating the augmentor is thrown overboard as it is transmitted to the circulating water passing through the augmentor condenser.

Simplicity.—The Leblanc air ejector is a static apparatus, and therefore does not require any attention during its operation. The condensate pump is of the centrifugal type without close clearances or valves to look after, and all that needs attention is the turbine bearings, since they should be supplied with sufficient lubricating oil. However, if there is a feed-oil system on board the ship, it may be used for supplying oil to these bearings, and then the condensate pump will not require any attention.

Maintenance.—The complete absence of internal rubbing parts, of reciprocating valves, etc., eliminates the wear and tear, and no repairs are required, which are frequent with pumps of the reciprocating type.

Small Steam Consumption.—The steam consumption of the air-ejector system is less than that of a reciprocating pump working in conjunction with a vacuum augmentor, when working under similar conditions.

The Westinghouse Machine Company, of East Pittsburgh, Pa., the sole licensee for all Leblanc patents relating to condensing apparatus, is now manufacturing this air ejector for marine condenser installations.

Monthly Shipbuilding Report.—The Bureau of Navigation, Department of Commerce, reports 88 sailing, steam, gas and unrigged vessels of 17,368 gross tons built in the United States and officially numbered during the month of October. Seven steel steamships, aggregating 9,866 gross tons, were built during the month, the largest being the *Plymouth*, of 5,266 gross tons, built by the New York Shipbuilding Company, Camden, N. J., for the Coastwise Transportation Company, Boston, Mass. From other sources than construction, 8 vessels of 19,467 gross tons were admitted to American registry during the month.

Dry Dock at Prince Rupert Tested.—The official test of the 20,000-ton floating dry-dock at the ship-repair plant at Prince Rupert has been made successfully and the plant is now ready for work. This plant, which includes, in addition to the dry-dock, a carpenter shop, shipbuilding shed and launching platform, machine shop, boiler and blacksmith shops and foundry and a power plant, was built by the Grand Trunk Pacific Railway in accordance with designs by Mr. William T. Donnelly, consulting engineer, New York.

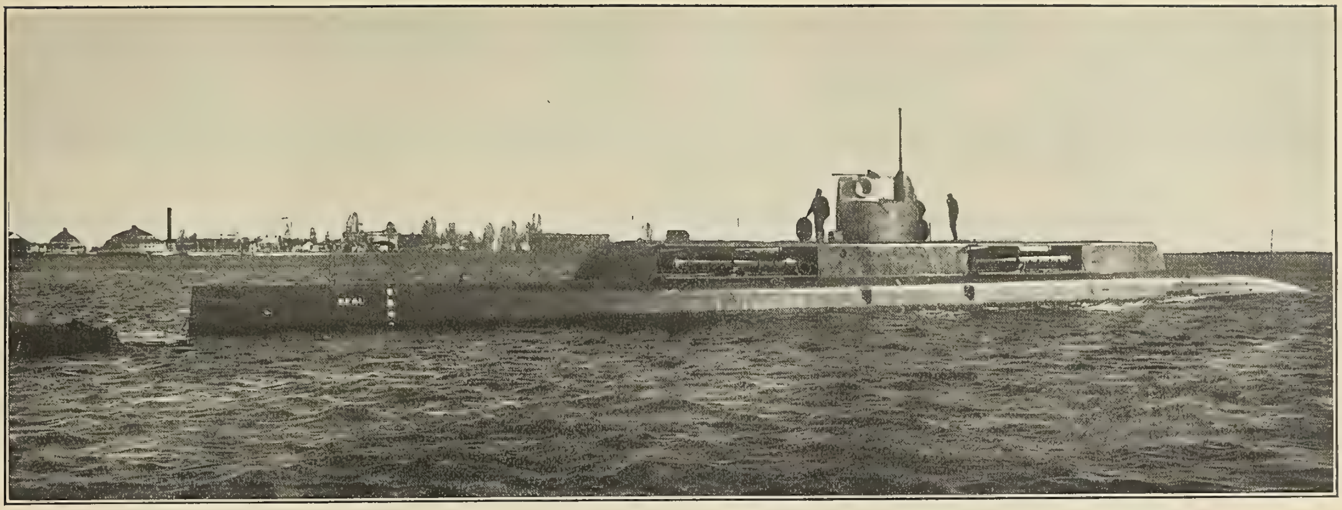


Fig. 46.—The *Seal,* or *G*-1

The *Seal* was the first submarine ever built to be fitted with torpedo tubes that could be trained to fire to either broadside. All other United States submarines must maneuver to bring the axes of the ship in line with the target before firing. This maneuvering is very apt to betray the position of the submarine's periscope when moving through the water, as it makes a white "wake" which can readily be seen by the observer on the enemy's vessel. If the periscope is at rest, however, and painted a neutral tint, it is almost impossible to see it even at a distance of three or four hundred yards. The ability to train the torpedo is therefore of importance, for it prevents the likelihood of the submarine's presence being known. The ability to train the torpedo is also of importance in that it permits the submarine to lie in wait for, and then pursue a course parallel to, the enemy's ship at close range. The enemy's ship is therefore within torpedo range a very much longer period of time than she would be if the submarine was forced to make a "head-on attack."

Modern Submarines in War and Peace—VI

Coast Defense and Cruising or "Fleet" Submarines—Value of So-called "Amphibious" Submarines for Defense Purposes

BY SIMON LAKE

Coast defense submarines will probably be found to be the most important adjunct to any navy in every country whose policy is to defend their own coast lines, rather than to become an aggressor. Vessels for this purpose do not need to be of great tonnage, nor of high speed. Speed is the one thing, more than anything else, which runs up the cost of the submarine vessel. While speed is desirable for the cruising submarine, it is not an essential for a defensive submarine. It is possible to get a speed of 14 or 15 knots in a submarine of about 500 tons displacement and at the same time have comfortable living quarters for the crew. A boat of this size may carry eight Whitehead torpedoes, each torpedo being capable of destroying a fifteen-million-dollar battleship, and as a 500-ton displacement submarine can be built for about one-half million dollars, and is capable of carrying eight Whitehead torpedoes, potentially good for eight fifteen-million-dollar battleships, or a total of one hundred and twenty million dollars' worth of capital ships, it seems as if that would be sufficient to ask of one little submarine boat.

Now, to double that speed would require a much larger vessel, and would cost approximately two and one-half million dollars. A two and one-half million dollar boat for the defense of harbor entrances or sea coast cities would not carry as many torpedoes as five of the 500-ton boats. A torpedo fired from a small boat is fully as potent as one fired from a two and one-half million dollar boat. These small boats could be located at five different points on our coast, and the chances are that at least two of these smaller boats could reach an objective point on the coast line under their protection in shorter time than one large high-speed boat would be able to do. At the same cost they could cover the same area of coast line to a much better advantage, as there would be five of them distributed over that area instead of one.

Vessels for coast defense should, in my judgment, be equipped to fire torpedoes in any desired direction while submerged. The *Seal,* or *G*-1, has been the only vessel thus far equipped with torpedoes which could be trained and fired to either broadside. The advantage of this lies in the fact that the vessel can lie at rest with only her periscope extending above the surface of the water. If the vessel is at rest, this periscope can be seen only at a very short distance, while if under way the periscope makes a white "wake" which betrays the presence of the submarine.

We will assume for purposes of illustration that the Sandy Hook entrance to New York harbor is to be defended. If we strike a 15-mile radius from Sandy Hook point, running from the Long Island to the New Jersey shore, and have four submarines take station on that radius line about 5 miles apart, no ship could pass that radius line without coming within the range of vision of the commander of the submarine, either from his periscope in daylight, or he would be well within the range of hearing of his "submarine ears." The Fessenden oscilators, or microphones, now installed in all submarines, would readily detect the approach of a surface ship or ships.

These instruments have been improved to such an extent that it is now possible to carry on "wireless" conversation under water between one submarine and another for a considerable distance. Communication by the Morse code, or other special codes, may be carried on between submarines up to a distance of several miles. It would be possible for groups of submarines on station, or picket

duty, so to speak, to be in constant communication with shore stations, either by submerged telephone connections, or by wireless. In that way the submarines can be kept in constant touch with the country's scouting fleet of high-speed surface vessels or aeroplanes and immediately be notified of the approach of an enemy's fleet or ship. There is no way in which they can themselves be detected, as far as I am aware, as there is no need to run the machinery of the submarine while lying at rest on picket duty, and it would be impossible for a surface ship or flying machine to detect them, providing a constant watch was kept on the horizon or the heavens through the periscopes.

As the range of the modern Whitehead torpedo is about three miles, no ship could pass between the submarines without passing within torpedo range. However, a commander of a submarine would hardly take a chance of making a hit at such a great distance, and on the enemy being sighted he would leave his station and attempt to intercept her, so as to get a shot at shorter range. If the enemy succeeded in running the gauntlet of the outer circle, they would have to pass the submarines distributed on, say, a 10-mile radius. Three submarines would be able to protect this radius line. A 5-mile radius line might also be established with two submarines, and one located at the entrance. A ship, to enter Sandy Hook, therefore, would have to run the gauntlet of five or six submarines without it being necessary for them to leave their stations.

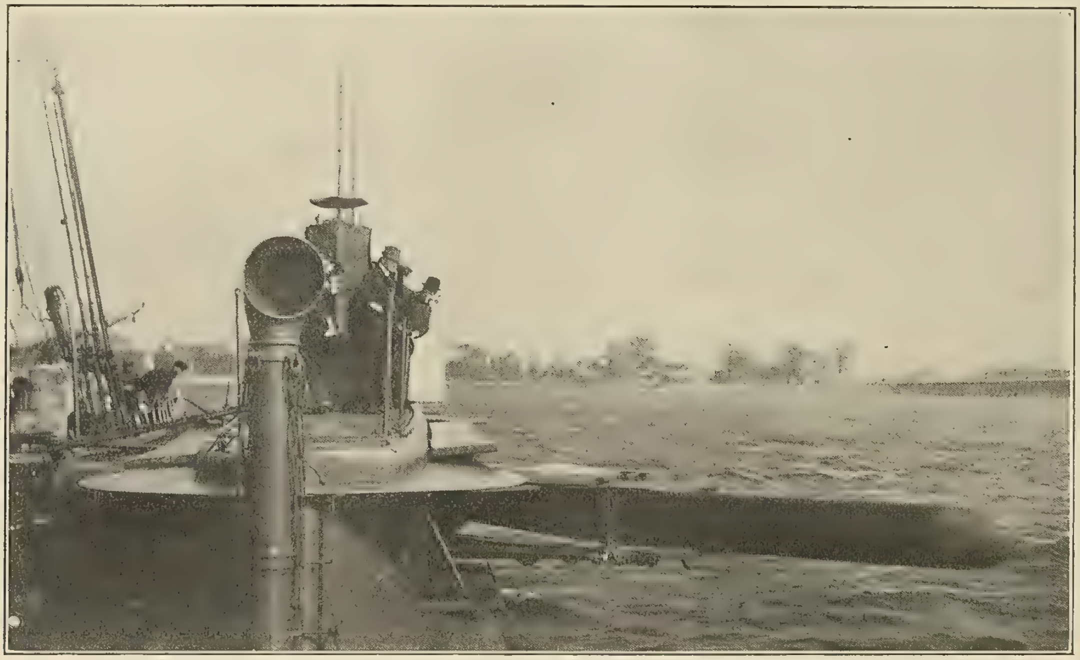


Fig. 47.—Torpedo Being Fired from the Deck Tubes of the Submarine G-1

This vessel was fitted with two double-barrel torpedo guns, housed in a superimposed superstructure. These four torpedoes could be fired to either broadside. The above photograph shows a torpedo in the act of leaving one of these tubes above water. They may be discharged either above or below the surface.

Fleet Submarines

Submarines with high speed will become valuable as commerce destroyers and for carrying on an offensive warfare. To stop wars between maritime countries it will probably be necessary to prevent countries having disagreements from carrying on commerce with any other country until they can agree to agree. Fig. 48 shows a high-speed, sea-keeping, fleet submarine of the Lake type. Its principal characteristics are the same as of the coast defense type except that the buoyant superstructure is increased in height sufficient to form living quarters for the crew when cruising in surface condition.

One of the essentials of a high-speed vessel is high-

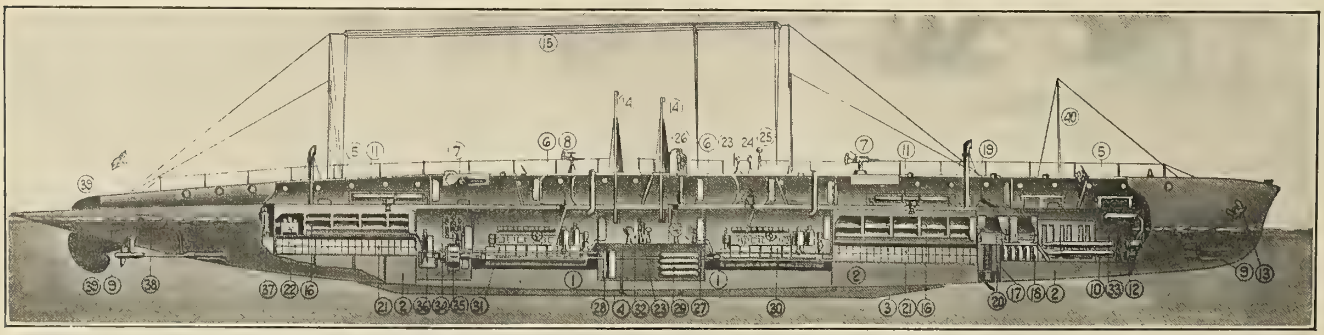


Fig. 48.—A Submarine Cruiser, or Fleet Submarine (Lake Type)

The parts indicated by numbers in this illustration are as follows: 1, main ballast tanks; 2, fuel tanks; 3, keel; 4, safety drop keel; 5, habitable superstructure; 6, escape and safety chambers; 7, disappearing anti-air craft guns; 8, rapid fire gun; 9, torpedo tubes; 10, torpedoes; 11, twin deck torpedo tubes; 12, torpedo firing tank; 13, anchor; 14, periscopes; 15, wireless; 16, crew's quarters; 17, officers' quarters; 18, warhead stowage; 19, torpedo hatch; 20, diving chamber; 21, electric storage battery; 22, galley; 23, steering gear; 24, binnacle; 25, searchlight; 26, conning tower; 27, diving station; 28, control tank; 29, compressed air flasks; 30, forward engine room and engines; 31, after engine room and engines; 32, central control compartment; 33, torpedo room; 34, electric motor room; 35, switchboard; 36, ballast pump; 37, auxiliary machinery room; 38, hydroplane; 39, vertical rudders; 40, signal masts.

powered machinery. A large portion of the interior of the pressure-resisting hull, therefore, must be devoted to machinery space. The high, buoyant superstructure also affords sufficient space below for the crew to rest when entirely submerged; the quarters would necessarily be somewhat cramped without the buoyant superstructure, which gives plenty of room for the crew to take exercise and secure plenty of fresh air when off duty, even in rough water. As it is very important to keep the physical condition of the crew and their spirits in a satisfactory condition, it is essential that they be not kept in restricted quarters for a long period of time.

This vessel is designed to carry torpedoes firing in line with the axes of the ship both fore and aft, and carries, also, torpedo tubes in the superstructure which may be trained to fire to either broadside. Of course such a vessel as this would be fitted with wireless and sound transmitting and detecting devices, and to be effective should have a speed of at least 25 knots, in which case she would be able to pursue and overtake any battle fleet that could be assembled from existing ships in any navy in the world. Undoubtedly such high-speed submarines will come into being within the next few years.

Congress last year appropriated money to build "fleet submarines" in which they expressed the desire to secure 25 knots. A certain amount of discretion, however, was left with the Navy Department, which would permit them to accept boats of not less than 20 knots. There is no difficulty in the way of constructing submarine vessels that will make 25 knots as far as the vessels themselves are concerned. There is no difficulty in the way of making such vessels function satisfactorily when submerged, but up to date no internal combustion engine has been produced suitable for such high-speed submarines, and steam has many disadvantages.

The tactics of the fleet submarine would be to search for and destroy the enemy's warships or commerce carriers wherever they could be found. A sea-going submarine of such character would also carry rapid fire guns of sufficient caliber to destroy surface merchantmen. Having sufficient speed to overhaul them, they would be able to capture the merchantmen and perhaps take them as prizes into their own ports, something which it is impossible for the commander of the small-sized submarines now in commission to do, as they have neither the speed to overhaul swift merchantmen nor guns of sufficient range and power to destroy them if they refuse to follow the instructions of the submarine commander. The only alternative, therefore, has been to destroy the merchantmen and, unfortunately, in many cases, the crew and passengers of the merchant ships have been destroyed as well.

"Amphibious" Submarines

From a study of the submarine problem as it stands to-day, the one thing lacking to make the submarine sufficiently powerful to stop commerce on the high seas between countries at war is speed. We have seen from the foregoing that sufficient speed to accomplish this purpose means great additional cost, and as the engine situation exists to-day, it may be considered that it is impossible. My own personal opinion is that we shall not see satisfactory 20-knot submarines, let alone 25-knot submarines, for a matter of three or four years. In the meantime, the people of this country, as well as all other countries not as yet engaged in the gigantic conflict which is taking place across the water, are becoming much exercised as to the possibility of some condition arising which may bring about an attack upon their own country.

There is a method of preparing this country at least with a type of submarine which may be navigated, so to speak, at much greater speed than that called for by last year's Congress, namely, 25 knots. The boats would have the further advantage in that they would be much less expensive even than the 14-knot submarines now called for in the latest specifications for the coast defense type. This new method calls for the construction of a moderate size submarine which, for the want of a better term to distinguish it, I have called an "amphibious" submarine—that is, a submarine which may be carried on land as well as on or under the water.

These submarines would be somewhat smaller than the present coast defense type of submarine, and of a diameter that could pass through our tunnels and over our bridges. They could be of about 250 tons submerged displacement. A railroad truck would be provided for each submarine with a sufficient number of wheels to carry the load. The submarine itself would be constructed with proper scantlings to carry her entire load of machinery, batteries, fuel and supplies without injury when mounted on her special trucks. Vessels of this type could be readily constructed that would have a surface speed of 10 to 12 knots and a submerged speed of 10 knots. They could carry as many as eight Whitehead torpedoes and have a radius of action on the surface of about 2,000 miles at 8 knots. Fitted with telescopic, or housing, conning towers and periscopes, nothing would need to be taken apart to ship these submarines from one section of the country to another at railroad speed. Fifty submarines of this type would in time of need probably be more efficient for protecting our thousands of miles of coast line than would many times the same number of 14-knot boats distributed over the same number of miles of coast line.

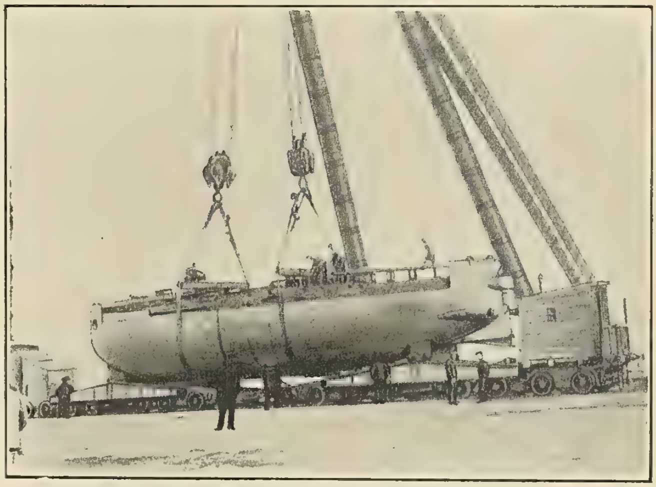


Fig. 49.—"Amphibious" Submarine

Making up a train to ship a Lake submarine across Siberia during the period of the Russian-Japanese war. Note the special trucks with sixteen wheels each, used to carry the load (about 130 tons). As the Trans-Siberian road had light rails, it was necessary to design these special trucks to distribute the weight so as to carry this heavy load. It is remarkable that several of these unheard-of weights should have been transported by vessel and rail a distance of over 10,000 miles each without accident or damage. Boats mounted on trucks especially designed to pass through tunnels could be transported from one port to another at railroad speed and be ready for immediate action in defending threatened sections of the country.

In the war game no one can tell where the enemy may decide to strike in force. An attack might be made in the vicinity of Boston, New York, Charleston, Pensacola, New Orleans or Galveston on the eastern coast; it might be made at or in the vicinity of San Diego, Los Angeles, San Francisco or Seattle on the western coast. There should be, of course, a certain number of the coast defense type of submarines permanently stationed at these ports

for their protection during war-time periods. But wars come suddenly, and the old saying that "the one who gets in the first blow has the advantage" is a true one. The history of recent wars shows that the declaration of war usually comes after the first blow has been struck. It is readily conceivable, therefore, that before we knew that we were going to become involved in war a fleet of battleships and transports stationed off our harbors, or off a suitable landing place on our extensive coast line, might be able to establish a shore base before we knew it or had time to get sufficient of our slow-going submarines at the danger point to prevent the landing of an invading force.

If we had one hundred submarines distributed over our Atlantic and Pacific coast lines, it would take weeks or months to mobilize many of them at the point of attack, government made arrangements with the railroads to run a track down under the water at each railroad coast terminal, or to run special tracks into the water at other suitable localities along the coast where there would be sufficient water to float a submarine, submarines could be rapidly mobilized to ward off a landing at any point.

Assume, to illustrate the point which I wish to make, that this country should become involved in war with nations lying both to the east and west of us. To get submarines from one coast to the other would require a long period of time. The "amphibious" submarine, on the contrary, could in an hour's notice be run onto the tracks at New York and three days later be run into the water at San Francisco, with her crew, fuel, stores and torpedoes all ready to go into action at once.

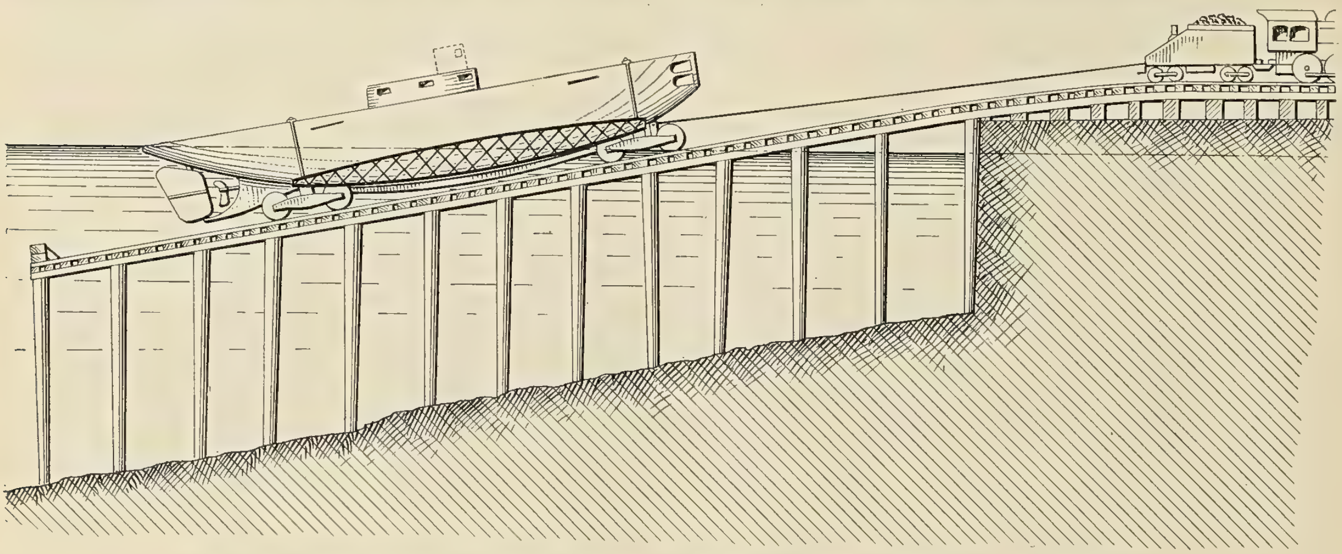


Fig. 50.—Hauling an "Amphibious" Submarine Out of the Water for Transportation Across Country

If the Government were to make arrangements with railroads to carry their tracks down under water, as indicated in the above diagram, special trucks could be built to carry submarines across country. It would be practical to build submarines of a size that would pass through railroad tunnels when mounted as above indicated, that would have a surface speed of 10 to 12 knots and a submerged speed of 10 knots, which would be ample for defense purposes. Such boats could carry eight Whitehead torpedoes and have a radius of action on the surface of about 2,000 miles. Fitted with telescopic conning tower and periscope, nothing would need to be taken apart for shipment by rail. On receipt of word that any particular section of the country was threatened, the "amphibious" submarines could be run on to their railroad trucks and within an hour after the word was received be on their way at railroad speed to the threatened locality.

for the reason that a submarine when submerged has such a small radius of action. The best in the service to-day have a radius of action of about 100 miles at 5 knots, or 11 miles at 10½ knots, or 24 miles at 8 knots. The enemy, with light, shallow draft, high-speed picket boats, could probably make it very unsafe for a submarine to travel any considerable distance along the coast in the daytime, or even at night, in surface cruising condition; and as it takes considerable time to charge the batteries to enable the boat to run in a submerged condition, if the enemy had control of the surface of the sea the average speed per day of a submarine would probably be less than 100 miles without running a grave risk of being captured while in the surface condition. The chances are, therefore, that if we had one hundred submarines distributed over our Atlantic and Pacific coast lines, not over ten or a dozen of them would be able to reach the point of attack in time to prevent the landing of an invading force with sufficient men, guns and ammunition to do a great deal of harm in some of the thickly populated sections of the country before our own citizens could be trained and provided with sufficient arms, ammunition, etc., to retake possession.

If, however, the country was provided with fifty "amphibious" submarines located at ten of our important Atlantic and Pacific ports, they all could be mobilized at an objective point within a week. If the

A submarine could make a trip from Boston to New York in five hours, or from Boston to New Orleans in thirty-five hours. These boats could be built in quantities at a cost of about $300,000 (£61,500) each. Fifty of them could, therefore, be built at approximately the cost of one modern battleship.

"Baby" Submarines

There has been much talk recently about the so-called "baby" submarines—little one- or two-man boats.

A large number of one-man submarines were built for the Russian Government previous to 1880 by Mons. Dzrewieckie, the well-known inventor of the Dzrewitckie type of torpedo-launching apparatus. Mr. Holland, Goubet and practically all inventors and builders of submarines commenced with "baby" submarines. One of the designs which I submitted to the United States Government in 1901 called for a one-man boat to be carried on the davits of a battleship or cruiser.

A boat of that kind might have had a place a number of years ago when attacking vessels came near the shore. Such small craft must necessarily have a very limited range of action and very slow speed; they also would be unseaworthy. It would be impossible for a man to remain submerged in a vessel of this type for a considerable length of time, so that, personally, I can see very little use for them at the present time.

(To be continued.)

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Engine-Room Floors

The modern steamer, while in many respects an improvement in equipment and comfort over those of a former epoch, leaves still some opportunity for minor improvements.

The usual engine-room floor to-day consists of chequer plating, and in drawing attention to the matter it is hoped that ship designers will give attention to an older expedient more comfortable to the engine-room staff.

Chequer plates are treacherous when rough weather is experienced. When of mild steel they polish readily by wear, and this, in combination with an eternally greasy condition, causes the unfortunate engineer to slither instead of walk from point to point on watch. Wrought iron chequer plates are not so bad as steel, while by no means a comfortable foothold. In the boiler room the grit of the coal and ash gives a more secure footing. As an example of the superiority of wrought iron, it is only necessary to cite the instances of horseshoes and boot tips, for both of which mild steel is barred from its dangerous tendency to polish.

For this reason of polish, mild steel chequer plates should be rigidly barred for engine-room floors. It is also desirable that such plates should be delivered unoiled. Accidents directly attributable to coating with boiled linseed oil as a protection against rust by the maker have occurred with newly laid floor plates.

Undoubtedly *the* most comfortable flooring under the conditions of greasy surface and heavy weather is sheet lead. Carefully treated, it is virtually indestructible; it possesses a substantial value as scrap metal if discarded at any time. It is impenetrable to damp and vermin. Sheet lead has a peculiar value as a roofing material, while its virtues under the conditions indicated are not so well known as they might be.

The underlying wood platform should be carefully laid, all joints smoothed down. Copper scupper nails fix it securely, and artistic ability can pattern these in a pleasing manner.

It can be cut and fitted with an ordinary pocket knife as easily as linoleum or oilcloth.

Lead sheet is manufactured not by wire gage, but as pounds per square foot, and a thickness of 8 pounds per square foot (a scant ⅛ inch) is sufficient for a floor. It is procurable in any width up to 8 feet wide and 40 to 50 feet in length. It can therefore be plotted to avoid undue waste in cutting up. The only drawback to a sheet-lead floor is its tendency to cut if mishandled or unfairly used.

The writer remembers a vivid, not to say lurid, interview with his chief when, owing to misadventure, a main bearing cap was slewed round on the platform, making a cut in a prominent place.

The rule was to deposit such articles when overhauling on a mat or rivet bag to save damage. By the way, it is remarkable how easily a large weight can be handled, deposited on a coir mat. The mat makes a sliding piece under the weight and enables quite heavy articles manageable by one man.

This particular floor of eight pounds of lead had been in existence for fifteen years, and during that time had been taken up twice for extensive repairs to the pipes and framing beneath the platform. The lead sheet, in spite of this, was in good condition and apparently of original thickness, while its non-slipping properties in a seaway have left grateful memories.

From experience, the writer can testify to its merits as the finest floor covering extant where grease and motion are plentiful. A. L. Haas.

London.

Removing a Rivet from Ship's Bottom Plating

Eleven years ago, while at sea as a junior engineer, the vessel I was on ran into a considerable head sea. She was trimming by the stern at the time, and this, coupled with the fact that the ship had very full lines forward, tended to make the pounding severe on the forward part of the vessel's bottom. The forward hold was only partly filled with cargo, so, when more water than usual was noticed in the bilges, an inspection was readily made and a leaking seam and loose rivet of the shell plating were found.

The seam was successfully calked; but not so with the rivet, which was very much loosened. By attempting to calk the head of this rivet with the calking tool and hammer, other rivets were started, due no doubt to the fact that the water pressure on the outside communicated the shock of the hammer to other rivets in the vicinity, just as attempting to calk a boiler under pressure might do. Finally, with careful and light calking, all but the one rivet were made tight.

After reaching port, and while discharging cargo, this rivet received attention. I heard it was the intention to replace the defective rivet, and thought it would mean going into dry dock. But, without docking and without a diver, the rivet was replaced with a bolt nutted on the inside of the ship as follows:

One end of a stout fishing line about 35 feet long was tied to and wound lengthwise on a small wooden reel about ⅝ inch wide by ⅛ inch thick and about 6 inches long, the other end of the line being made fast inside the ship near the rivet. When all was ready, the defective rivet was backed out (overboard), and the reel with line wound on was shoved through the hole and allowed to float up to the surface, unwinding as it went. From a boat alongside the reel was picked up and the end of the fishing line made fast to the threaded shank of a ¾-inch bolt. Then the line was hauled from below (inside the ship) and the bolt entered into the hole, where it was held while the fishing line was removed and a washer and grommet and nut were put on and set up hard. This latter was comparatively easy, as the bolt was long and threaded the whole length.

In fact, the whole job seemed quick and easy, except the wetting of those below, who had it impressed upon them what a lot of water can come through a small hole in the bottom of a ship. William S. Owen.

Webb's Academy of Naval Architecture, New York City.

The Oldest Steamboat in the World

The photographs shown below may be of interest to readers of International Marine Engineering as they show a group of old-time steamboats, a rapidly disappearing type. These vessels were tied up at Rondout, N. Y. In the foreground of Fig. 1 is the *Norwich,* the oldest

Fig. 1.—S. S. *Norwich*

Fig. 2.—S. S. *Oswego*

steamboat in the world. Astern of her is the *Oswego,* the next oldest steamboat, while in the background is the famous *Mary Powell,* long known as the "Queen of the Hudson." Fig. 2 also gives an excellent view of the *Oswego.* C. D. Davis.

Worcester, Mass.

Peculiar Accident to Circulating Pump

A somewhat peculiar accident happened recently to our circulator. Soon after geting under way one night the condenser heated up suddenly, and it was necessary to put on the fire pump to maintain any vacuum at all, and, as the fire pump was entirely too small to furnish enough condensing water, we had to run slow while we investigated the trouble. Our first conclusion was that the strainer over the injection valves had become choked with grease, but, after thoroughly blowing them out and getting no better results, we stopped long enough to remove some of the hand hole plates from the condenser head, but found no obstruction there. This left nothing else to do but to examine the impeller and shaft.

Fortunately, the design of this pump was such that the forward bearing and stuffing box could be removed easily (which is a very good thing and by no means universal with pumps of this kind). This gave us access to the hub of the impeller and we found that the key was gone. This was strange, because the hub of the impeller was long enough to just clear and turn fully between the bottoms of the stuffing boxes, being 6¾ inches long with an open space of about 2 inches in the center, so that it was impossible for the key to get out except by breaking into at least three pieces and working out at the center, one piece at a time. But the keyway showed no sign of the key having become loose, as it necessarily would have done had that been the case. The key could not have become loose and broken in three pieces and finally worked out in the manner described without damaging the keyway enough to at least leave some visible evidence of that having occurred. The keyway was as smooth and clean-cut as when new.

The only plausible explanation of the disappearance of the key is that probably a steel key was fitted when the pump was built (it was then about four years old), and, as it corroded, it became even tighter in the keyway where it was fitted, and, as there was not much of a load on it, it probably did not let go till it became thoroughly disintegrated, and when the impeller finally slipped the key went all to pieces, which would account for its disappearance. Of course, it is not likely that the designer specified a steel key for this bronze impeller and shaft, but occasionally the designer proposes and the mechanic disposes in minor details that are not subject to particularly close inspection.

The key was a rectangular section 9/16 inch by 15/16 inch, and we had some cold-rolled steel in the storeroom ½ inch by 1⅛ inches, so we cut off a piece of that and split a piece off the side with a hack saw, making it ½ by ⅞ inch, and slipped it in place and went on at full speed, after losing about an hour. Next day in port we fitted a forged bronze key, and have had no further trouble with it.

Norfolk, Va. D. Sawyer.

Electric and Oxy-Acetylene Welding

The welding process of repairing boilers has made rapid advancement during the past three years. It has unquestionably solved some problems of repairing boilers in an inexpensive and satisfactory manner, but there still remains the fact that in many cases work attempted by this process has proved a failure. Most of the failures, however, are due to the lack of knowledge of the effects of the electric arc and the flame of the oxy-acetylene torch by the operator. Both skill in applying the process and knowledge of the effects are absolutely necessary for the successful operation of this process.

The larger concerns who do this kind of work employ only skilled operators, but there are many smaller concerns who do not have sufficient work of this kind to make it profitable enough to pay the high wages commanded by skilled men, the result being that many times work is done that should not have been attempted. The writer has seen some of these instances and hopes that a description of them will be of benefit to the practical operating engineer.

The side sheets in the furnaces of a leg boiler in a tugboat had cracked between the staybolts in several places and it was decided by the concern which owned the boat to have the cracks repaired by the welding process. A firm which had authority to use this process on marine work was communicated with and one of their representatives stated, after examining the boiler, that it could be satisfactorily repaired by the oxy-acetylene welding process, the kind used by them. They sent one of their operators with appliances for doing the work and he began operations on a crack that extended from a staybolt hole

for a distance of three inches when he began. Before he had done much welding the crack had extended to the next staybolt hole. When he had welded this crack its entire length he discovered that a new crack had started between two staybolt holes two feet away from the one he was working on. He welded the new crack and found that this had started another crack between two other staybolt holes. The same result took place when this crack was welded and the operator became discouraged, as did the superintendent of the concern who owned the boat.

A telegram brought on the next train another representative of the firm which had contracted to do the work, and he took charge of the work. Being an expert in this kind of work he soon discovered that the oxy-acetylene welding process would not successfully repair cracks in side sheets that had become extremely brittle by reason of crystallization. A few cuts with a hammer and cold chisel revealed the brittleness of these sheets, and had this expert examined the boiler the first time he would not have undertaken the job. The old sheets were cut out and replaced with new material.

In another case the top of the back ends of two corrugated furnaces in a Scotch boiler had cracked out from the rivet holes to the edge of the furnaces. These ends were cut off all the way around and the furnaces lengthened on the front ends by riveting pieces on them and then drilling new holes in the back ends and refastening them in place. In a short time they again cracked in the top of the back ends where the flame of the fires struck. A firm which did repair work by the electric welding process claimed that the cracks could be repaired by their process and were given the job. When it was completed there was at least one-half inch of material welded on the top of the back ends of the furnaces, extending in over the rivets. With two thicknesses of metal—the flanges of the flue sheets and the furnaces—and this addition of welded material, between the fire and water there could only be failure, and the welded ends of the furnaces soon burned, leaking worse than ever and had to be replaced with new ones. Only a person who lacked knowledge of the effects of fire on metal would have undertaken to do this job in this manner. Undoubtedly these cracks could have been welded by cutting them V-shaped and then filling up the V's level with the sheet.

Another instance of the lack of knowledge of the effects of the heat of the electric arc on the material on which it was being used occurred on a pleasure steamer. This yacht was constructed of steel and the plates of the hull were of extremely light material. These plates had corroded in places under deadlights, toilets and bath tubs, and it was thought that they could be reinforced in these places, which were not of very great area, by the welding process. This opinion was confirmed by a representative of a firm who did this work and he was given the job. When he had completed the reinforcing of the first spot the plate he was working on had wrinkles in it between the frames that surprised the operator and horrified the owner of the yacht. The operator had no knowledge of the effects of the heat of the electric arc on light steel plates.

It was then decided to cut out the portions of the plates that were deteriorated. This was attempted by the use of the electric arc, but this also proved a failure. The edges of the plates when cut were too uneven to calk and required chipping. On starting to do this it was found that the material had hardened so much that it was a slow and expensive job to chip the edges and the use of the electric arc was abandoned.

None of these jobs would have been attempted had an expert in the use of the welding process been in charge of the jobs in the first instance, and these failures prove that this work should not be entrusted to any but experts.

New London, Conn. J. S.

Forced Feed Lubrication Aboard Ship

From extensive inquiry, the consensus of opinion is that successful practice in the use of oil comes from unceasing care in handling. Reliable dealers when they sell an oil for a certain purpose are very certain that it will fulfil that purpose and are very glad to aid in any way they can. They have in their employment the best chemists and practical engineers available. They spend thousands of dollars yearly, and their success as oil distributors depends upon the successful operation of the oil they sell. So it is reasonable to assume that when an oil apparently does not do its work the method of application and not the oil is at fault.

Faults may be inherent of the installation or, what is more probable, of the care and handling. The object of the installation is to (1) supply the requisite amount of oil to the desired bearings in varying amounts as demanded; (2) to supply it at the desired temperature—this includes heating and cooling apparatus; (3) to allow sufficient storage; (4) to provide a method for purification, the removal of sediment and water, it being safe to assume that no system is so perfect as to discount these two items.

The amount of supply is a matter of pipe and pump design. There is little choice in the pumps on the market, the ordinary plunger type is very good. For small installations the gear pump is excellent. Pipe diameter must be sufficient to allow a generous supply and to keep the velocity below the critical point. Sharp bends must be guarded against. In laying out the piping it will be found of much value to have a slightly curved section in preference to a straight section, so that when setting up sections this curve will allow the joints to be well made. Ground flange faces, while initially expensive, are cheaper in the long run. The suction lines must be above the highest possible level of bilge water, otherwise a leaky joint on the suction line will fill the system with dirty bilge water.

Heating coils are unnecessary on ships. With the engine room temperature varying very little, it is hard even to imagine a possible condition where they are necessary, except for ships operating in high latitudes. They may aid in settling, but not to such an extent as to authorize their installation on account of the cost, liability of leaks, increased weight and inconvenience in cleaning the tanks. Cooling coils should never be installed in a tank. Use an oil cooler; it is more efficient and leaves the tanks free for cleaning. Many oil tanks are not properly cleaned because of the mass of piping installed in them.

The supply tank must be of sufficient capacity to insure a generous supply. There are many rules. The best practice is to copy a successful installation. The tank should have at least a capacity equal to one-tenth of the hourly supply pumped through the system. Oil can be used over and over for periods varying from six months to a year, if properly filtered and cared for. The tank must be of sufficient size to fill the system and then have an available supply of from 50 to 100 gallons, depending on the size of the installation. In a large installation, as a battleship, there must be at least 100 gallons available. Knowing rate of supply, keep at least two minutes' supply available, as it will take at least this time to shift connections.

The tank must have three connections: (1) supply (this should be at the top); (2) suction (water and sediment

settles to the bottom, so this connection must be above the highest possible water level; in a 400-gallon tank this water deposit may run as high as 40 gallons); (3) drain pipe to run water off (this must be at the bottom and lead to the bilges). The matter of cruising supply is often neglected. Oil will keep indefinitely, hence no loss results from deterioration or other loss attendant to keeping from 500 to 1,000 gallons on hand. A small leak will eat up 200 or 300 gallons in less time than it takes to tell about it. As a minimum in a large installation there should be a reserve of at least 500 gallons. This entails an investment of about $75 (15/12/6). Ordinarily, when cruising, the make-up oil should not exceed 2 gallons a day.

To illustrate the necessity of supply I will quote an incident that happened to me several years ago. While in charge of a turbine installation of about 10,000 horsepower, a leak developed in a spring bearing. The result was an hourly loss of 20 gallons. The ship had to keep going, and luckily we were carrying a reserve of 500 gallons, due to previous experience. It might also be stated that this reserve was being carried at considerable inconvenience. Previous to this a sister ship had made port on a mixture of water, gasoline (petrol), pump oil, cylinder oil and graphite, the use of said mixture causing several weeks' work. A reserve of 500 gallons in this case would surely have been a saving. Anyone who has spent a day working around oil lines will appreciate this in all its beauties.

Next comes the filtering system with its many troubles. Oil filters are like the measles, we don't like them but we have to have them, and once you have them they are a constant source of irritation, and unless properly treated leave bad after effects. To begin with, most oil filters are too small. Very much like three deuces, they give you confidence, but you don't brag about them. The oil must have time to filter. If sent through too rapidly, the filters are useless. The filter must be cleaned regularly, at least weekly, and oftener if possible. There are examples where the filters have not been opened for months and the operator in the meantime has been yelling about the poor oil the distributors supply, when in reality the oil was excellent and he was only showing up himself. A dirty filter will contaminate the best of oil. If your oil is gradually becoming contaminated, try your filter and it is a good bet that the trouble is there.

The following is a method that I have found to be good in keeping an eye on the oil. Every three or four days take a pint bottle and fill it from the tank in use. Allow it to settle and the water and sediment will collect at the bottom. Any increase in contamination will be discovered at once.

If you wish to go into the subject still more, the following is recommended. Upon request the distributors will supply to you a neat case containing a sample of each oil that you have in use. When the oil is received, compare it with the standard sample as regards color, odor and general characteristics and satisfy yourself that you have received the proper oil. Now each oil has a characteristic color and odor that after a little practice can be easily recognized. As the oil continues in use the color changes, and as a rule the oil gradually becomes darker. To one unfamiliar with oils it may seem to indicate that your oil is going bad, but this is not so. To satisfy this fear try the following method: When the oil is received fill a small bottle, lay it aside and mark this No. 1, with the name of the oil and the date; two weeks later remove another sample, mark this No. 2, noting the date. You will notice that No. 2 is darker than No. 1. Remove about five of these samples and you will notice that Nos. 4 and 5 show little change in color. These five samples will give you a good line on the manner in which the oil should change color and will give you a color scale for reference with future oil of the same kind.

The oil, while darker, should in all cases be clear; if cloudy, the chances are that water is present in excessive quantities. As regards odor, not much can be said. This is a matter of practice and experience except that water gives the oil a stale, rank odor that is easily recognized. The above-mentioned samples are also of great help in the determination of the amount of water and sediment present.

One of the principal sources of contamination aboard ship is foreign oil. Now this sounds foolish, but, believe me, it is very often sad, as mixing a compound oil with a straight oil is very much like using turpentine instead of olive oil. If you don't believe it, just try it—yes, I mean both. The favorite way for this foreign oil to get in the system is via the rod glands. All cylinder oils leave more or less deposit, and as steam blows through, this deposit is blown down the rod and sooner or later finds its way to the crank pit, and from there into the supply tank. This sounds "fishy," but some day, when the rest of the gang is scrubbing the anchor, sit down (though real engineers are not supposed to do this) and figure out how many times your piston rods travel up and down during six months. And if you should have the misfortune to get an oil mixture you will think that Sherman was talking of oil systems and not of war.

Well, to go back to our filters, the data on filtration are limited, and what really good data there are can only be obtained from the distributors. And let me say right here that they are always willing to help you and in most cases will send a representative upon request. This fact is either little known or often neglected and I most earnestly advise anyone who has troubles to take them to your distributor, and in this way save time and money and at the same time give their oil a fair show.

Oil troubles aboard ship are many and to go into detail would take many pages, but there is one more that I would like to mention, and that is water in the oil. Water aboard ship is always a proposition, and we all acknowledge that the captain uses enough daily to supply make-up feed for a week, but when it comes to getting it in the oil system, well, it is plain, ordinary h——. And the worst of it is that you can't keep it out. Its effect on the system is the same as the effect of the mule on the fellow who twisted his tail—hospital. Oil as received will contain in the vicinity of 1 percent water. On board ship it will collect from 5 to 10 percent water. If it goes over five percent, an investigation should be started. The best way to nip it in the bud is to use the sample bottles mentioned above. Notice how strong I am for those sample bottles. Just try them and you will be, too. The water and sediment settle to the bottom and any increase will be noticed at once. You can get action before there is anything except water in your system and the journals begin to show pit holes big enough to tap.

What has been said above applies to all ship installations in general. Specific cases require their own analyzing. In experience with various installations, large turbines, high speed generators, large and small reciprocating engines, the points mentioned have been found to be quite general. In addition there are many other points as regards viscosity, flash point, etc., that come under the chemical end and need not be considered here, but which are nevertheless very important. Oil troubles aboard ship are, in nine cases out of ten, due to water and poor filtering conditions. In other words, out of every ten cases there is one in which the oil may be at fault and nine in which the care and management are at fault. D.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Elastic Limit and Yield Point

Q.—Is there any difference between the elastic limit and yield point in testing a specimen by tension? M. T. L.

A.—Properly the elastic limit is the point where the specimen *begins* to distort at a greater rate than the load increases—i. e., when the ratio of stress to strain departs from a constant value. The yield point is commonly considered as the point at which the weighing beam of the testing machine rather abruptly drops and the specimen

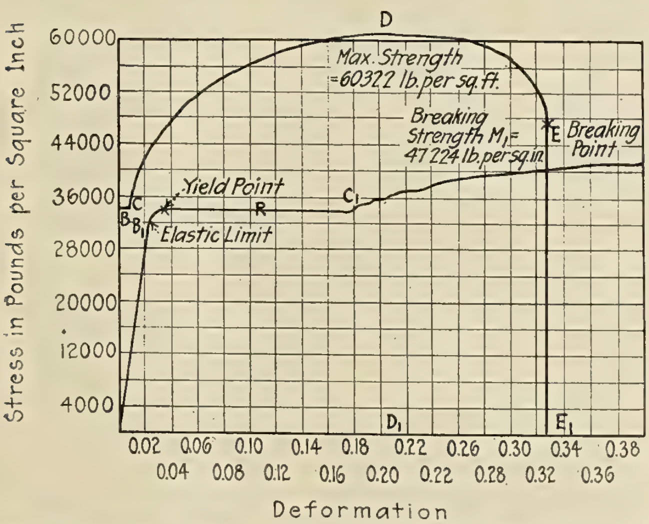


Diagram Showing Elastic Limit and Yield Point as Determined by Test

elongates appreciably at constant load. In some materials the points are very close together, but usually the yield point is a bit higher than the elastic limit (see diagram). Curve *B C D* shows entire test, *B-C* being the yield point. Curve B_1-C_1 is the early part of the same curve plotted to a much larger horizontal scale, and shows the difference between the elastic limit at B_1 and the yield point much more clearly.

Critical Temperature

Q.—Will you kindly give me a short and understandable definition of "critical temperature?" I find the term appearing much in works on refrigeration, and, so far as I can interpret the definition, it appears to be that temperature above which you cannot liquefy a gas by compression. C. T. R.

A.—If, in your conception, you interject the word "economically" so that it reads that the critical temperature is that temperature above which you cannot economically liquefy a gas by compression, you will have a very workable comprehension of it without going into the thermodynamic conception involved. For example, the critical temperature of carbon dioxide (CO_2) is about 31 degrees F., and if we cool the gas to that temperature or lower, it will readily liquefy by the expenditure of a reasonable amount of work per pound of resulting liquid. If, however, we had the gas at a temperature of 48 degrees F. (only 17 degrees higher), it would have required *more than twice* as much work to compress it from the same original volume to the liquid condition, and would have required an enormous final pressure. The great saving in the first method is due simply to the fact that the temperature of the gas being compressed was lowered to or below its critical temperature.

An Indeterminate Question

Q.—Can the following question be worked out without the diameter of the shaft being given: Eccentric, 15 inches diameter, 5-inch throw; move it on shaft ½ inch; crank on dead center. How far will it move the valve? J. K.

A.—As given, the question is strictly indeterminate, as the ½-inch movement referred to is presumably measured circumferentially on the surface of the shaft, and this distance corresponds to an angular displacement which would be proportional to the radius of the shaft.

Calculations for Size of Boiler

Q.—What is the best method used for figuring the size of boiler required for supplying a fore-and-aft compound engine with cylinders 10 and 20 inches diameter by 14 inches stroke, cutting off at 10½-inch stroke; working pressure of boiler, 160 to 165 pounds; piston speed, 600 feet per minute? Probably natural draft would be used, but would you advise what difference in the size of the boiler it would make if forced draft were applied? Do you consider that a Fitzgibbon type boiler or a submerged tube, vertical type, would answer just as well as a Scotch boiler? H. J. G. McL.

A.—The best method is to determine the probable steam consumption of the engine and provide a boiler with sufficient grate and heating surfaces to supply this steam. This necessitates first a determination of the probable indicated horsepower of the engine. The general formula for mean effective pressure (theoretical) is

$$\text{M. E. P.} = p_1 \frac{1}{n} (1 + \log_e n) - p_3,$$

where p_1 = boiler pressure,
n = total number of expansions,
p_3 = back pressure,
if p_1 = 160 pounds per square inch,

$$n = \frac{10 \times 10 \times \pi \times 14}{5 \times 5 \times \pi \times 10.5} = 5.33,$$

and p_3 = 4 pounds per square inch (assumed),

$$\text{then M. E. P.} = 160 \times \frac{1}{5.33} (1 + \log_e 5.33) - 4,$$

$$= 160 \times \frac{1}{5.33} (1 + 1.6734) - 4,$$

$$= 80.2 - 4 = 76.2 \text{ pounds per square inch.}$$

The ratio of theoretical mean effective pressure to probable mean effective pressure is about .55 for this type of engine, so that the indicated horsepower to be expected is

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$$\text{I. H. P.} = \frac{\text{M. E. P.} \times \text{Piston Speed} \times \text{Area L. P. Cyl.}}{33{,}000} = \frac{41.9 \times 600 \times 314}{33{,}000} = 239.$$

A steam consumption, including auxiliaries, of 25 pounds per horsepower hour is reasonable for this type of engine and gives $239 \times 25 = 6{,}000$ pounds per hour approximately, as the evaporation of the boiler. The equivalent evaporation from and at 212 degrees is

$$\frac{\text{Heat contents at 165 pounds} \times 6{,}000}{\text{Heat contents at 212 degrees}} = \frac{1{,}196 \times 6{,}000}{1{,}150} =$$

6,200 pounds approximately.

$$\text{Boiler H. P.} = \frac{6{,}200}{34.5} = 180.$$

For Scotch boilers about 7 pounds steam per square foot of total heating surface is as much as should be counted on, which would give $6{,}000 \div 7 = 857$ square feet, and, allowing 35 square feet of heating surface per 1 square foot grate, the required grate area is $857 \div 35 = 24.5$ square feet. Therefore, a Scotch boiler for the given conditions should have about 860 square feet of heating surface and 24.5 square feet of grate area.

If forced draft is used it is probable that the horsepower per square foot of grate area would be about 15, which would give a much smaller boiler.

Unless the weight is prohibitive, the Scotch boiler will probably be most satisfactory.

Reduction of Speed of Vessel Due to Foul Bottom

Q.—Can you tell me approximately what reduction in speed could be attributed to a foul bottom in the case of a vessel 350 feet by 48 feet by 26 feet draft which made a speed on trial of 13 knots? F. B.

A.—The effect of fouling is to increase the skin resistance, and it has recently been shown that very dirty bottoms may readily increase the skin resistance 400 percent. To gage the effect of foulness by the loss of speed is an insensitive standard, as the power varies as the cube or higher power of the speed. For the vessel quoted, probably the frictional resistance would be about 70 percent of the total resistance, so an increase of 400 percent would effect an increase in total resistance to about 300 percent and would reduce the speed about as

$$\frac{13}{\sqrt[3]{3}},$$

or, roughly speaking, to 9 knots. Of course in practice such fouling should be permitted only under exceptional conditions. In cool waters a vessel three or four months from docking may have an increase of frictional resistance of about 200 percent which would correspond to an augmentation of total resistance of about 70 percent, with an approximate reduction in speed to about

$$\frac{13}{\sqrt[3]{1.7}} = 10.9,$$

or 11 knots, approximately.

How to Figure the Coal Consumption per Indicated Horsepower per Hour

Q.—Will you kindly let me know in your next issue how to find out the pounds of coal per indicated horsepower per hour used on a ship? I assume that you have the data necessary. What I want is how to go about working out this problem from beginning to end. R. V.

A.—The data necessary would be taken from daily reports or from trial trips, and are as follows:

Indicator cards from the engine.

Revolutions per minute of engine shafts.

Coal used during the trial.

From the indicator cards and the scales of the springs used, the mean effective pressures may be determined. In detail, the mean effective pressure of a card is equal to the area (found by planimeter) divided by the length and multiplied by the scale of the spring. The indicated horsepower may then be found from the formula

$$\text{I. H. P.} = \frac{PLAN}{33{,}000}$$

where P = mean effective pressure in pounds per square inch,
L = length of stroke in feet,
A = effective area of piston in square inches,
N = number of revolutions per minute.
33,000 foot pounds of work done per minute = one horsepower.

The horsepower for the other end of the cylinder is determined in the same way. The sum of the two gives the total horsepower for the cylinder. Then, knowing the coal used per hour and the total indicated horsepower, the pounds of coal per indicated horsepower per hour may be found.

Shipbuilding and Repair Plant for the Galveston Dry Dock and Construction Company

The Galveston Dry Dock & Construction Company recently secured a site in Galveston, Texas, for the erection of a shipbuilding and repair plant which will be capable of handling repair work for any class of vessels entering the port of Galveston, and also for the construction of vessels of all types up to a length of 300 feet.

The first step toward the establishment of this plant will be the installation of a Crandall railway dry dock suitable for repair work on tugs, sailing vessels and light steam vessels. The construction of this dry dock, which necessitates an outlay of about $75,000 (£15,400), is rapidly being pushed to completion, and it is expected that the dock will be ready for business early in 1916.

As an important feature of this plant, plans are being prepared for the construction of a modern floating dry dock composed of five sections, with a combined lifting capacity of 8,500 tons. The extreme dimensions will be: Length, 460 feet; width, outside, 110 feet, and width inside of wings, 83 feet. The dock can be submerged to a depth of 22 feet over 4-foot keel blocks. The five sections will each be 80 feet in length, the two end ones being provided with a semi-circular outrigger, or extension, at a radius of 30 feet. A sixth section can also be added if desirable. The pumping system will comprise four 12-inch centrifugal pumps to each section, the combined capacity of the four pumps being about 16,000 gallons per minute. Each pump will be entirely independent of the others, and any one pump can free one entire section from water in case of a breakdown.

Long Voyage of Diesel-Engined Yacht

The yacht *Southwark,* equipped with a Southwark-Harris valveless engine operating on the Diesel principle, sailed from Philadelphia on October 18 for an extended trip to Panama and then up the west coast to Seattle, provided, upon arrival at Panama, the yacht could proceed through the Canal. The yacht is 98 feet long, 16 feet beam and 7 feet depth. The engine uses a common grade of crude or fuel oil and on a recent trip from Philahelphia to New York and return the cost for fuel was $8.20 (1/14/2) and for lubricating oil $1.84 (7/8½), making a total cost of $10.04 (2/1/10½). Both the yacht and the engine have been fully described in previous issues of International Marine Engineering.

Marine Articles in the Engineering Press

Dry Docking Facilities in Japan—Lesson from the Lusitania Disaster—A New Lightship and Self-Unloading Freighter

Japanese Dry Docking Facilities.—By E. R. Thompson. This article contains two tables, one giving the particulars of the government's dry docks in Japan and the other the dry docks available for mercantile vessels. For naval purposes there are seventeen docks available, varying in length from 265 to 777 feet. For the merchant marine there are seventeen dry docks available for vessels up to 300 feet long; fifteen for vessels up to 350 feet; eleven for vessels up to 400 feet; seven for vessels up to 450 feet; five for vessels up to 500 feet, and one for vessels up to 700 feet. The number of dry docks at present available seems to be sufficient for the work to be carried out, but the Japanese sea-going trade is rapidly increasing, and in the future a greater number of large dry docks will probably be required. 1,700 words.—*The Shipbuilder,* August.

Solid Fuel from the Technical and Commercial Standpoint.—By A. E. Battle. This paper explains the application of the approximate analysis of coal and the purchase of coal on a calorific basis for marine purposes. The classification of coal is generally based upon the volatile hydrocarbons present. These hydrocarbons greatly influence its burning, its suitability for special purposes and, to a large extent, the design of the fire grate. The commercial varieties of coal are broadly classified under three heads: lignites, bituminous coal and anthracite. The characteristics and qualities of these coals are explained and the marine engineer is urged to obtain a more accurate knowledge of the fuel that he is using, as this, combined with a slight knowledge of practical funnel gas analysis, would lead to better results than are ordinarily obtained. The writer points out that it is not necessary to be a highly skilled chemist to perform an approximate analysis and he describes a simple manner in which the quantity of moisture, hydrocarbons, carbons, ash and sulphur contained in the coal may be determined, and also the calorific value. The author expresses surprise that at least a snap analysis apparatus to test the funnel gases is not fitted even to well-equipped liners; for it is a well-established fact that operating without some scientific control is open to the inroad of losses heavy and difficult to detect. 7 illustrations. 5,500 words.—*Transactions of the Institute of Marine Engineers,* September.

A Lesson from the Lusitania Disaster.—By William Hovgaard. The author examines first the case of the sinking of the *Lusitania* and second the case of what would have happened in the same circumstances to a ship like the *Titanic,* subdivided on the purely transverse system. The results of this investigation lead to the following conclusions: That the number of transverse subdivisions should be considered as fundamental in the design of all vessels, merchant ships as well as warships, simply because longitudinal stability is always much greater than the transverse, and in sea-going ships is certainly about a hundred times as great. That longitudinal subdivision is intrinsically pernicious on account of the small transverse stability of all ordinary vessels, and should be used only when absolutely necessary. That all wing or side compartments, where such must be fitted, should either be so small that their heeling effect when flooded will be negligible, or, if that is impracticable, as may be the case in warships and auxiliary cruisers, they should be in permament connection with corresponding compartments on the other side of the ship, so as to eliminate the heeling effect automatically. Provision may be made, in addition, for pumping water into the side compartments. In pure merchant vessels no side bunkers or other longitudinal compartments of so large volume as to require such needs of compensation should be allowed. 2,000 words.—*Engineering,* September 3.

Some Technical Aspects of Shipbuilding Contracts.—By H. Bocler. This is a continuation of an article begun in the preceding issue, which dealt with the preliminary considerations entailed by direct guarantees or requirements in regard to deadweight and draft, cubic capacity, trim and stability. The present article deals with flotability when damaged, strength, speed and power. It is now usual for purchasers of passenger vessels to specify certain requirements in respect to the number of damaged compartments with which the vessel should be capable of remaining afloat. The minimum requirements in regard to the watertight sub-divisions of passenger vessels have been established by law in conformity with the provision of the recent International Conference on Safety of Life at Sea. To comply with the conference requirements it is first necessary to construct what is termed a curve of floodable length for the ship—that is, a curve showing at any point in the length the maximum percentage of the ship's length, having its center at the point in question, which can be flooded under the definite assumptions formulated in the conference report in regard to freeboard and permeability. In preliminary designing work it is impracticable in many cases to make the lengthy calculations necessary for an exact determination of the curve of floodable length, and investigations into the number and spacing of bulkheads necessary to comply with the conference requirements have presented considerable difficulty. The Bulkhead Committee have, however, in their recent report published a series of standard curves for obtaining curves of floodable lengths which greatly facilitate the application of the conference requirements. If, as is highly desirable, these curves are accepted by the Board of Trade, in so far as local requirements are concerned shipbuilders will be confronted with a comparatively clear issue.

Stipulations may also be made in regard to the important question of stability when damaged—a matter about which the conference report says nothing, but which may be the governing factor in regard to the capability of the ship to remain afloat. When confronted with special requirements in regard to freeboard and stability with certain consecutive series of compartments flooded, the designers' preliminary investigations prior to the conclusion of the contract need only determine that values in excess of the stability requirements can be obtained. There is no need to determine exact values. It is also usually unnecessary to investigate every series of compartments.

Strength as a primary feature in design is concerned only with the structural strength of the ship as a whole, and when a vessel of normal type and size is built in accordance with the rules of one of the registration societies it is not usual to have any specified requirements involving strength calculations. If, in special cases, strength calculations are required, two factors are in-

volved. First, the straining actions, due to the unequal longitudinal distribution of weight and buoyancy, and, second, the amount and distribution of the material in the longitudinal members of the ship's structure which resist these straining actions. The usual procedure for making these calculations is outlined.

Speed is a primary economical factor in ship design, which must, in the first place, be settled by the ship owner to suit the economic considerations of the trade for which the vessel is intended. The only guarantees which can be required are for the fulfilment of the trial trip speed. The question is largely one of reserve boiler power, but allowance has also to be made for weather conditions. Various methods used for estimating power to give designed speeds are outlined briefly. A margin of at least 5 percent above a reasonable estimate of the power would in the majority of cases be allowed for when designing the machinery. 9 illustrations. 4,500 words.—*The Shipbuilder,* August.

New Graving-Dock at Ferrol Dockyard.—In order to place the government establishment at Ferrol in a satisfactory condition for the repair and maintenance of the new Spanish fleet, the Sociedad Española de Construcción Naval has constructed at this dockyard a new graving-dock designed and built under the supervision of Messrs. Sir John Jackson, Ltd. The length of the dock at the level of the keel blocks from the outer caisson stop to the stem is 573 feet 4 inches. The maximum width of the dock at the cope at the entrance is 101 feet 9 inches and on the floor of the dock 68 feet 11 inches. The depth of water on the sill of the entrance at the usual flood tide is 37 feet 1 inch. The dock entrance is formed with a caisson groove in the side walls and floor and an outer stop at the outer end of the entrance, in accordance with the latest British admiralty practice. The caisson has a length of 102 feet, a height of 50 feet ½ inch and a draft in ballast of 21 feet 7¾ inches. The raising and lowering of the caisson is carried out automatically by a series of valves which allow the water to flow in or out, as may be necessary. There are no pumping arrangements in connection with the caisson. The pumping station for emptying the dock is situated near the entrance and consists of two 3-foot diameter centrifugal pumps which are capable of emptying the dock in five hours on a falling tide. 13 illustrations. 1,800 words.—*Engineering,* September 3.

Big Self-Unloader Put in Service.—By R. V. Sawhill. A description of the self-unloading limestone-carrying freighter, *W. F. White,* built this year by the American Shipbuilding Company, Lorain, Ohio, for the Limestone Transportation Company. The vessel is 550 feet long overall, 530 feet length on keel, 60 feet breadth, molded, and 31 feet depth molded. Her capacity is 10,000 tons on a 19-foot draft, and she is equipped with a system of conveyors furnished by the Robins Conveying Belt Company, New York, which is designed to unload 1,700 tons an hour. The vessel is of the single deck type, arch girder, steel construction, the cargo hold being divided into three separate compartments. A continuous double hopper extends fore and aft through the cargo space, the cross section of the hopper being in the form of a flattened "W" with an extreme width of 60 feet. A double bottom 4 feet deep is fitted, extending from the engine bulkhead to the collision bulkhead. It is divided by a center keelson and watertight bulkheads into ballast and trimming compartments. The total water ballast capacity is 7,500 tons. There are twenty-nine hatches, 38 feet wide and 9 feet fore and aft, spaced 12 feet centers. The propelling machinery consists of a triple expansion engine with cylinders 25½, 41 and 67 inches diameter and 42 inches stroke, developing 1,800 horsepower. To handle the water ballast, three Warren ballast pumps are installed, one a 14-inch centrifugal and the other two 12-inch by 16-inch by 18-inch horizontal duplex pumps. The air pump of the Edwards type and the bilge and cooler pumps are attached to the main engine. The boiler feed, pony, mate's and sanitary pumps are all furnished by the Warren Steam Pump Company. Steam is supplied at 185 pounds pressure by three Scotch boilers, 13½ feet in diameter and 11 feet long, fitted with Ellis & Eaves system of induced draft. The steering gear of the American Shipbuilding Company's direct-connected type is in duplicate. To handle the cables six single-drum mooring engines with 8-inch by 10-inch cylinders were supplied by the American Shipbuilding Company. A 10-inch by 10-inch spur-geared steam windlass was also furnished by the shipbuilding company for handling two 8,000-pound anchors. The electrical equipment consists of two 15-kilowatt direct-connected Engberg generators. The article gives a detailed description of how cargo is unloaded by means of the conveying machinery. The vessel cost $500,000 (£101,000) and was completed 163 days after the order was placed. The work of constructing the vessel actually represented 134 working days. 8 illustrations. 3,400 words.—*The Marine Review,* October.

The Irish Commissioners' Lightship Petrel.—The lightship *Petrel,* built to the order of the Irish Lights Commissioners by the Dublin Dockyard Company, Ltd., of Dublin, is 102 feet long on the waterline, 24 feet 3 inches breadth molded and 13 feet 4 inches depth molded. There are two decks and six principal watertight compartments. The watertight compartment abaft the engine room is fitted up as an oil room and contains ten large cylindrical oil tanks, each capable of containing 200 gallons of heavy machinery oil from which the engines and light apparatus are supplied. The mooring arrangements consist of two cables each of 220 fathoms of 1¾ inch open link, each chain handled by a Harfield windlass worked by a compressed air plant as well as by hand. The lantern, located 40 feet above the waterline on a strong steel mast 2 feet in diameter, is 8 feet 6 inches diameter and 10 feet 9 inches high, supplied by Messrs. R. Merrick & Co., of Cork. The source of the light is 35 millimeter oil incandescent mantles. The engine room contains the oil engines, air compressors, air receivers and other appliances in connection with the disphone equipment for the fog signal. The duplicate set of machinery for compressing the air for the fog signal consists of two sets of oil engines each of 12½ brake horsepower by Messrs. Richard Hornsby & Sons, Ltd., of Grantham, Dublin. The air compressors are fitted on the same beds as the engines, each unit being capable of delivering 100 cubic feet of free air into the air receivers, this air being compressed to a pressure of 30 pounds per square inch under normal working conditions. The oil is pumped up to the lanterns under a pressure of 60 pounds per square inch. 2 illustrations. 1,500 words.—*The Shipbuilder,* August.

Institution of Naval Architects.—The annual meeting of the Instituion of Naval Architects will be held in London on April 12, 13 and 14, 1916.

American Society of Mechanical Engineers.—The thirty-sixth annual meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies Building, New York City, December 7 to 10. The spring meeting of the society will be held at New Orleans, La., April 11-14. A feature of the December meeting will be special exercises to honor the memory of the late Dr. Frederick W. Taylor, past-president of the society.

Shipbuilding and General Marine News

**Contracts for New Ships—Marine Terminal Improvements—
Recent Launchings—Improved Appliances—Personal Items**

The demand for oil tank steamships has long been recognized as the barometer of shipbuilding conditions in the United States, and in the present unprecedented rush for American-built ships the oil companies have been the leaders. Although something like 400,000 tons of oil tank ships have already been ordered from American shipbuilders, present conditions show no signs of a lessening demand for ships of this particular type.

Steamship owners handling bulk and miscellaneous cargoes have also not been slow to take advantage of vacant building slips for new construction, as is evidenced by the wide diversity of orders for new ships recorded in this column during the past few months. To secure early delivery of vessels of large tonnage, however, is becoming an impossibility, for not only is the capacity of existing shipyards taxed for months to come, but the enormous export of steel products from the United States is likely to cause delays in the delivery of shipbuilding materials.

Contracts for New Ships

The Maryland Steel Company, Sparrows Point, Md., has received a contract from the Standard Oil Company of New Jersey, Bayonne, N. J., for two large tank steamships.

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has received a contract from the Standard Oil Company of New Jersey to build two large tank steamships.

The Seattle Construction & Dry Dock Company, Seattle, Wash., has received a contract to build a 5,000-ton steamship for an unknown company.

The Shell Oil Company, San Francisco, Cal., is reported to have placed an order with the Union Iron Works, San Francisco, Cal., for five large tank steamships.

The Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., has received a contract from W. R. Grace & Co., New York, to build two steamships of 10,000 tons net register to cost about $1,000,000 (£205,000) each. These ships will be used between United States Atlantic ports, the west coast of South America and the Pacific ports of the United States.

The Toledo Shipbuilding Company, Toledo, Ohio., has received a contract from the Great Lakes Steamship Company, Cleveland, Ohio, to build a 600-foot steamer to cost about $450,000 (£92,300).

The Maryland Steel Company, Sparrows Point, Md., has received a contract to build a freight steamship for the Bull Insular Steamship Company, New York. This order is in addition to the three boats already ordered from the Maryland Steel Company by the A. H. Bull Steamship Company.

The American Shipbuilding Company, Cleveland, Ohio, is reported to have received orders for three large steamships in addition to those previously reported. One of these is a 600-foot ore boat for H. S. Oakes, Cleveland, Ohio.

It is also reported that the order which the American Shipbuilding Company has for two bulk freight steamers for a firm in Christiania, Norway, will shortly be increased to six ships, as Norwegian ship brokers are swamped with orders which they are unable to fill in Europe.

As a result of this state of affairs, the Toledo Shipbuilding Company, Toledo, Ohio, has received orders from Norway for four 5,000-ton motor ships for the oil trade.

The Chester Shipbuilding Company, Chester, Pa., will build two turbine steamships for Norwegian owners.

The Union Iron Works, San Francisco, Cal., is reported to have closed a contract to build three steamships for the Japanese trade. It is reported that the Union Iron Works, in addition to the orders already reported for oil tank steamers, will build five steamers for independent oil interests on the Pacific Coast.

The Staten Island Shipbuilding Company, West Brighton, N. Y., has received a contract from the Lehigh Valley Railroad Company, Philadelphia, to build a 109-foot steel tug.

Theodore A. Crane's Sons Company, New York, has received a contract from the Lehigh Valley Railroad Company to build two 10-foot barges.

The American Bridge Company, Pittsburg, Pa., will build seven steel car floats for the Lehigh Valley Railroad Company.

It is reported that the Chilean Government has placed a contract with a Connecticut Shipbuilding firm for five submarine boats to cost about $500,000 (£102,500) each.

F. S. Bowker, Phippsburg, Me., will build a three-masted schooner for Rogers & Webb, Boston, Mass.

Robert Palmer & Sons Company, Noank, Conn., has received a contract from the Philadelphia & Reading Railroad Company, Philadelphia, Pa., to build six 207-foot coal barges.

The Greenport Basin & Construction Company, Greenport, L. I., is said to have closed a contract with the British Government for the construction of 100 launches, each 60 feet long and with a speed of 27 miles an hour.

The Herreshoff Manufacturing Company, Bristol, R. I., is building a 109-foot auxiliary schooner yacht.

The Great Lakes Engineering Works, Detroit, Mich., has a contract from the Merritt & Chapman Derrick & Wrecking Company, New York, to build a steel ship of Welland Canal size.

The John H. Mathis Company, Camden, N. J., will build two car floats for the Philadelphia & Reading Railway Company, Philadelphia, Pa.

The Lehigh Valley Railroad Company, Philadelphia, Pa., will build a steel tug, 109 feet long, for use in New York harbor.

The Submarine Boat Corporation, Quincy, Mass., has received an order from the Spanish Government to build six more submarines, making a total of fourteen submarine boats to be built by this company for the Spanish Government.

The Submarine Boat Company is also negotiating with another foreign power to build ten submarine boats.

It is reported that the Standard Motor Construction Company, Jersey City, N. J., has just received an order to build two hundred large motor engines.

It is reported that the Canadian Vickers Company, Montreal, Canada, has received an order to build three hundred "submarine chasers" for the British Government. These boats, according to reports, are to be 75 feet long, and to have a surface speed of 20 knots.

The Morse Dry Dock & Repair Company, South Brooklyn, N. Y., has received a contract from the War Depart-

ment, Washington, D. C., to repair the U. S. army transport *Kilpatrick* at a cost of $34,000 (£6,950).

The Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., is reported to have received contracts aggregating more than $1,000,000 (£205,000) for repair work on ships.

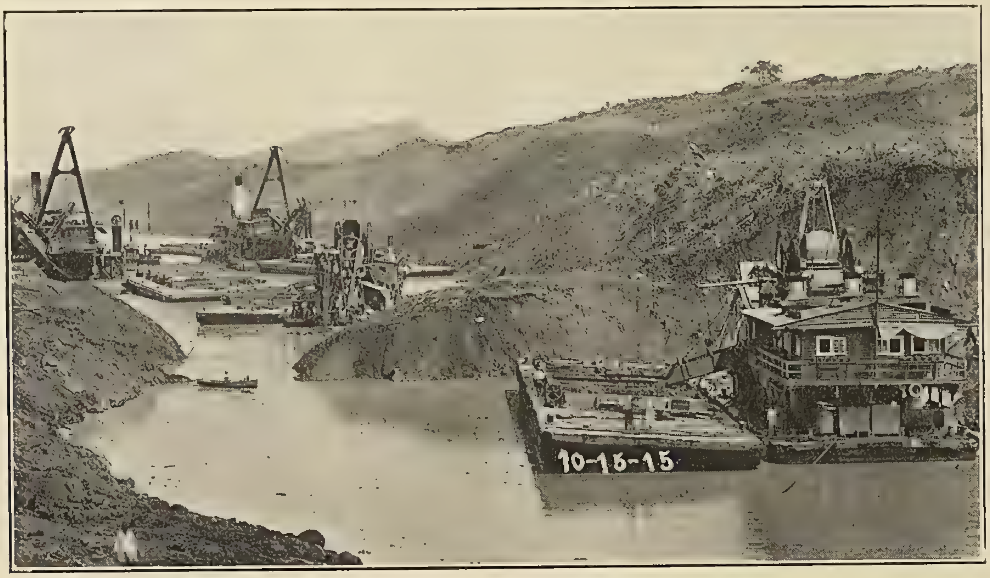
Shipyard Expansion and Improvements

The Standard Shipbuilding Corporation has been organized in the State of New York with a paid-up capital of $3,000,000 (£615,000). Wallace Downey, 8 Bridge street, New York, is the moving spirit in the new company, which has made arrangements to open the shipyard at Shooters Island, New York. It is reported that the company already has offers of contracts amounting to $8,000,000 (£1,640,000).

Many of the shipyards of the country are being much enlarged so as to be able to handle the unprecedented amount of business now on hand. Among the companies which have recently let contracts for the enlargement of their plants is the Fore River Shipbuilding Corporation, Quincy, Mass., which will build a slip larger than any now in its yard. The new ways will be 138 feet wide and 800 feet long. The Fore River Shipbuilding Corporation now has contracts to build one battleship, three destroyers, twenty-one submarines and nine merchant steamers; the total cost to be nearly $28,000,000 (£5,750,000), and it is estimated that new buildings and equipment already ordered will cost $2,000,000 (£410,000).

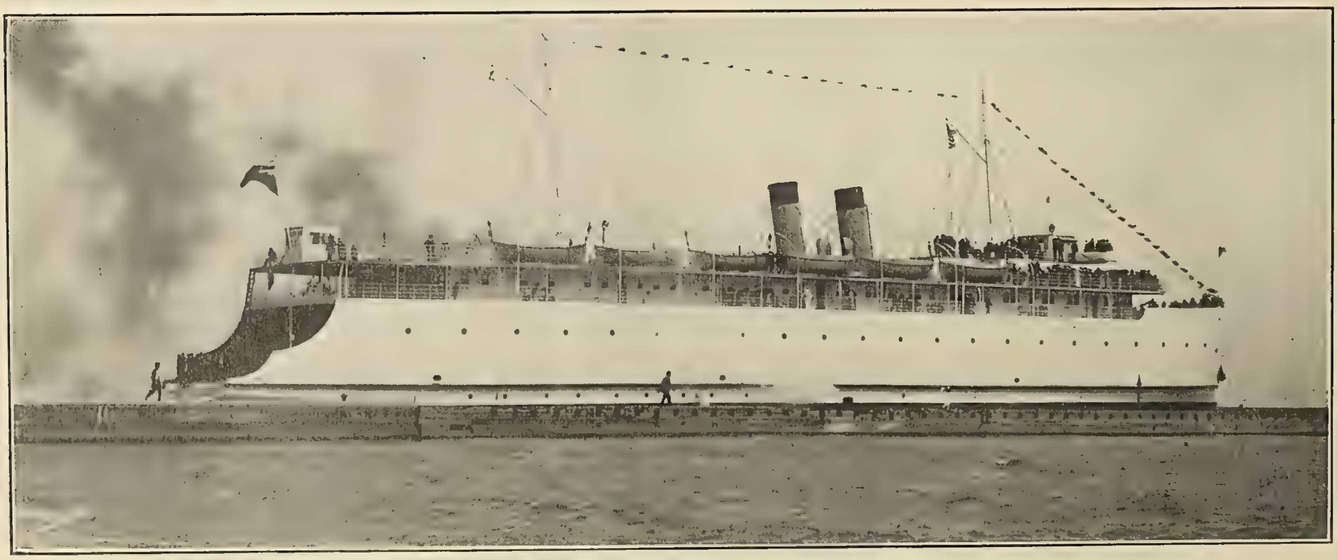
The New York Shipbuilding Company, Camden, N. J., has begun work on two new ways. The company has on hand contracts to build ships to cost about $15,000,000 (£3,080,000).

The Lake Torpedo Boat Company, Bridgeport, Conn., has bought a large amount of land on which it will build a new yard, so that it will be possible for the company to build torpedo boat destroyers and scout cruisers.



View of the Recent Slide in the Panama Canal, Showing Dredging Operations

The Morse Dry Dock & Repair Company, Brooklyn, N. Y., is planning to build a sectional floating dry dock of 27,000 tons capacity at the foot of Fifty-eighth street, Brooklyn. This will be the largest dry dock of its type in the United States.

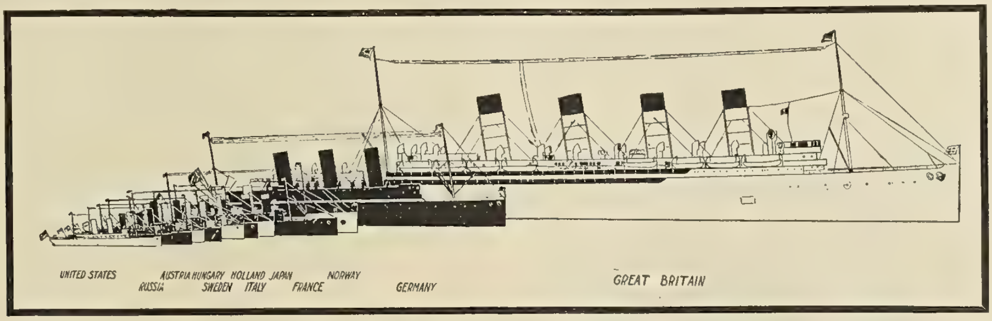


Twin-Screw Car Ferry *Ontario No 2* of 5,400 Gross Tons Built by the Polson Iron Works, Ltd., Toronto, Ont.

Shipbuilding Contracts Pending

The Pocahontas Navigation Company, New York, which has already placed contracts with the New York Shipbuilding Company, Camden, N. J., for three steamships, will, so it is reported, build a number of additional ships in the future.

Capt. C. W. Jungen, manager of the Atlantic Steamship Lines of the Southern Pacific Company, New York, announces that bids will be called for shortly for two large freight steamships to ply between New York, New Orleans and Galveston.



Graphic Illustration of the Urgent Need of an American Merchant Marine. The United Staes Is Eleventh Among the Nations in Ship Tonnage in Foreign Trade

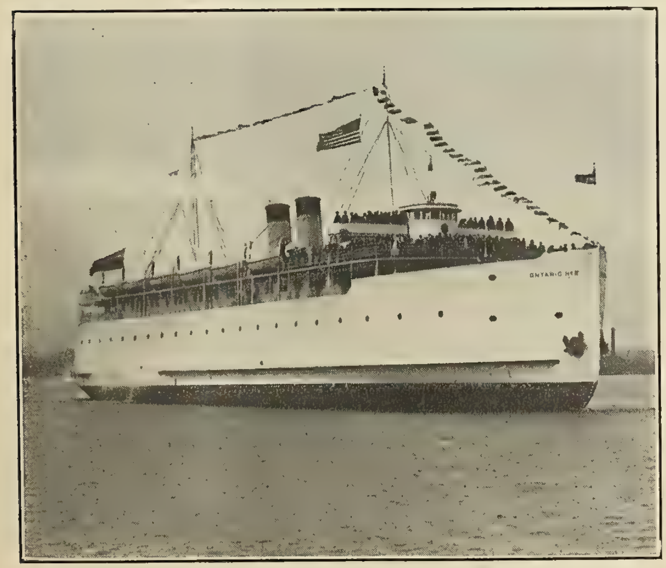
Messrs. Esplen & Sons, Ltd., New York, are reported to be in the market for ships for account of English steamship concerns, and if satisfactory arrangements can be made will order any number of ships up to fifteen or more.

Messrs. Esplen & Sons, Ltd., are also understood to be in the market for a marine engine of about 1,200 horsepower, with shafting, etc., to install in a ship already built.

The Macon & Atlanta Navigation Company, Macon, Ga., has increased its capital stock to $200,000 (£41,000) and will, so it is reported, construct additional power barges.

New Steamship Lines

The Pacific & Eastern Steamship Company has been incorporated in the State of New York with a capital stock of $2,000,000 (£410,000). Half of the capital has been subscribed by Americans and half by Chinese. The American interests are represented by F. Mertens' Sons of Cumberland, Md., and Washington, D. C.



Bow View of *Ontario No. 2*

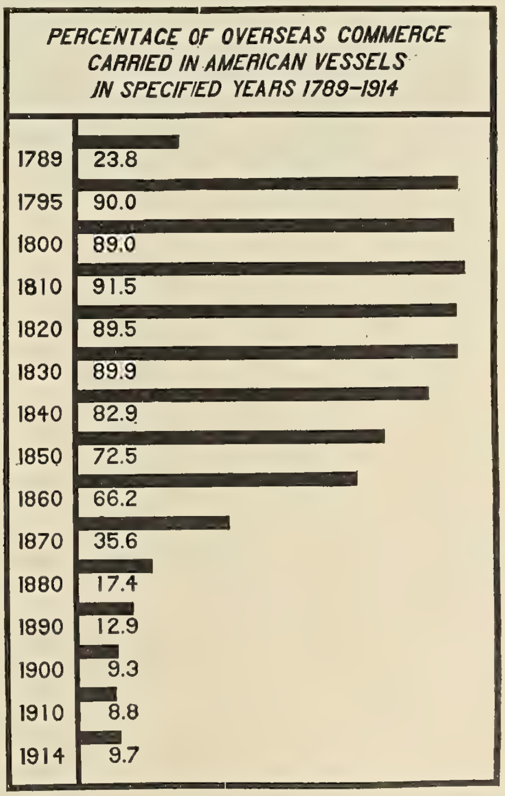
The Lumber Exporters Line has been organized in Gulfport, Miss., to operate a steamship service to export Southern hard wood lumber to Europe.

The Majestic Steamboat Company has been incorporated in Alexandria, Va.

It is reported that a company to be called the France & Canada Steamship Company, has been organized at Toronto, Canada, with a capital stock of $1,000,000 (£205,000) to inaugurate a steamship service between Canada and France.

Appeal for Larger American Merchant Marine in Foreign Trade

The urgent need of a larger American merchant marine for carrying on the nation's foreign trade is graphically illustrated by the two diagrams which are printed on this page, through the courtesy of the National Marine League. These diagrams show that the United States is eleventh among the maritime nations in ship tonnage in foreign trade, and that less than 10 percent of the over-seas commerce is now carried in American vessels.



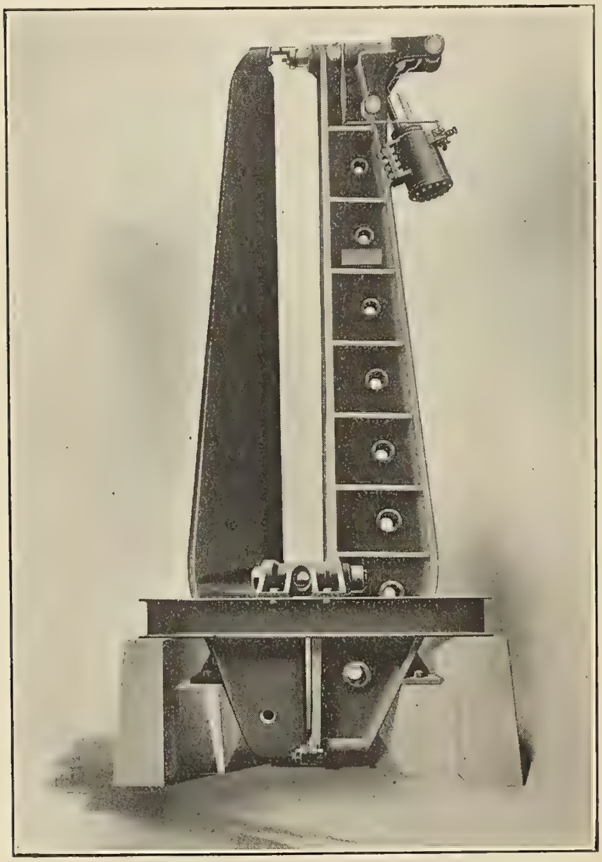
The Reason Why the United States Should Have a Larger Merchant Marine

ENGINEERING SPECIALTIES

Large Pneumatic Riveter

Two of the largest pneumatic riveters ever constructed have just been built by the Hanna Engineering Works, Chicago, Ill. The machines have a reach of 21 feet and are capable of exerting a pressure of 100 tons on the rivet die at 100 pounds air pressure. Each machine weighs 40 tons.

In the Hanna type of riveter toggles, levers and guide links are combined to give the large opening of the toggle joint movement with its gradually increasing pressure



Hanna Pneumatic Riveter, with Reach of 21 Feet

until the desired pressure is reached, then a simple lever movement throughout a considerable space under approximately maximum pressure. This space is sufficient, so that there need be no uncertainty about the pressure applied on the rivet; and the machine once adjusted for a certain length of rivet and thickness of plate, will require no further adjustment for ordinary variations in length of rivets, size of holes, or thickness of plates.

The machines are furnished with cylinders having 22 inches of piston stroke with a relative travel of 5¾ inches of the rivet die. The toggle action takes place during the first half of piston travel, which represents approximately the first 4¾ inches of die travel. At this point the mechanism automatically changes into a simple lever action, without a critical point, thus producing the rated tonnage of the machine at the rivet die, practically uniform for the last 1 inch of die travel. By the use of a pressure regulating valve in the air supply line to the riveter, the pressure of air at the cylinder can be quickly changed to vary the pressure on the rivet dies to produce any tonnage the operator may deem advisable for any size of rivet he may wish to drive.

An Interesting Test

Recently one of the large steamship companies in the United States submitted two ring life buoys to a 28-hour test—one of solid cork covered with canvas and the other of balsa wood, half of which was covered with canvas. The balsa wood ring buoy is of the type manufactured by the Welin Marine Equipment Company, Long Island City, and known as the A. B. C. ring buoy. It is 30 inches diameter on the outside and 18 inches diameter on the inside. For the comparative test both ring buoys were put overboard into the water and to each was attached a weight of 32 pounds. They were left undisturbed for a period of 28 hours. At the end of this time the cork buoy was almost totally submerged, floating about an inch lower in the water than when first placed in the water. The balsa wood buoy floated apparently the same as when first placed in the water.

An Unusual Yoke Forging

Recent developments in the self-unloading cargo boats on the Great Lakes have made necessary the use of an unusual yoke forging. In the case of the steamship *W. F. White,* which was built this year by the American Shipbuilding Company, at Lorain, O., the vessel was equipped with an unloading mechanism designed to unload her

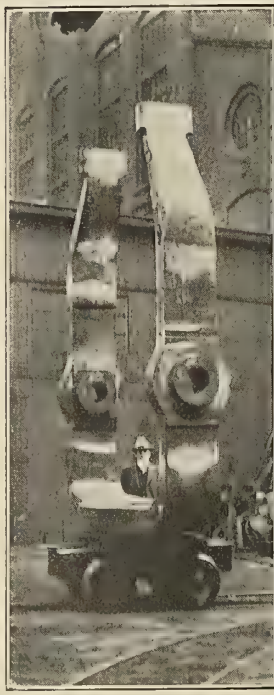


Fig. 1

Fig. 2

cargo of 8,500 tons at the rate of about 2,000 tons per hour. A yoke forging carries a boom, hopper and the machinery operating the main carrier belt, which is driven by an 11-inch shaft. The boom is carried on milled trunnions and will deliver the cargo from the steamer on any dock 150 feet from the centerline of the ship. The yoke forging on this vessel was made by the Delaney Forge & Iron Company, Buffalo, N. Y.

The rough forging weighed 24,000 pounds. Figs. 1 and 2 show the forging bent to shape and ready to ship. The extreme width is 9 feet 11 inches and the extreme height 13 feet 2 inches. The finished weight is 19,500 pounds.

PERSONAL MENTION

Operating Engineers

George S. Kreutzer, of Paducah, Ky., is chief engineer of the river steamer *Hibernia.*

Albert Windfield, of Paducah, Ky., has been appointed engineer on the towboat *Redspot.*

James Shepard, of New Orleans, La., has been appointed first assistant engineer of the steamer *Ponce.*

Anthony Amnedo, of New Orleans, La., has been appointed chief engineer of the tug *Wash Gray.*

James Pulaski, of New Orleans, La., has been appointed third assistant engineer of the steamer *Somerset.*

William F. Brookes, of New Orleans, La., has been appointed chief engineer of the steamboat *Florence.*

James L. Yent, of New Orleans, La., has been appointed second assistant engineer of the steamer *San Juan.*

George Richardson, of New Orleans, La., has been appointed chief engineer of the tug *Asher J. Hudson.*

E. L. Milbury, of New Orleans, La., has been appointed second assistant engineer of the steamer *Massapequa.*

A. J. McMillan, of New Orleans, La., has been appointed first assistant engineer of the steamer *Rosalie Mahoney.*

E. S. Mildey, of New Orleans, La., has been appointed second assistant engineer of the steamer *John D. Archbold.*

Ambrose Van Wie has been appointed chief engineer of the tug *Marguerite* at Albany, N. Y., vice Paul Cramer, resigned.

Charles Bortle has resigned as chief engineer of the steamer *William H. Kinch,* of the Great Lakes Dredge & Dock Company, Albany, N. Y.

George B. Langin, chief engineer of the tug *Mary M.,* has been transferred to the tug *Lydia,* of the Miller Dredging Company, Albany, N. Y.

W. D. Hardester, of Paducah, Ky., has been appointed assistant engineer on the river steamer *North Star.* James L. Weston is chief engineer of this vessel.

Frank Beck, of New Orleans, La., has been appointed chief engineer of the tug *Maud Wilmot.* Jacob Huber has been appointed assistant engineer of this tug.

Elsworth B. Mealy has been promoted to the position of chief engineer of the tug *Florence W.,* of the Randerson Dredging Company, stationed at Mechanicsville, N. Y.

Henry Stammell, formerly chief engineer of the tug *Lydia,* at Albany, N. Y., has been appointed chief engineer on the steamer *Paul LeRoux,* which is to be stationed at Waterford, N. Y.

Ed. L. Latham, who has been acting chief engineer of the river steamers *Alabama* and *Kentucky* at Paducah, Ky., has resumed his former position of chief engineer of the river steamer *St. Louis.*

George Smith, chief engineer of the Potomac & Chesapeake Steamboat Company, Washington, D. C., is in New York supervising the overhauling of the steamer *Majestic,* recently purchased by the Potomac & Chesapeake Steamboat Company for the Potomac River route.

William C. Claflin, chief engineer of the tug *Florence W.,* of the Randerson Dredging Company, Mechanicsville, N. Y., has resigned to act as chief engineer of the freight annex steamer *Mary Gordon,* of the Manhattan Navigation Company.

Henry Van Loon, of Athens, N. Y., formerly chief engineer of the passenger steamer *William M. Whitney,* of the Albany & Troy Steamship Company, has been appointed chief engineer of the steamer *William H. Kinch,* of the Great Lakes Dredge & Dock Company, Albany, N. Y.

Naval Architects, Consulting Engineers, Draftsmen and Shipyard and Steamship Officials

W. D. Smith has been elected president of the American Shipbuilding Company, Cleveland, Ohio.

E. H. Howell, formerly in the armor section at the New York Navy Yard, Brooklyn, N. Y., has been placed in charge of the new work section at the yard.

G. R. Martin, formerly assistant to the chief draftsman of the machinery department of the New York Navy Yard, Brooklyn, N. Y., is now with the American Steam Gauge Company, Boston, Mass.

George W. Harney has been appointed supervising inspector of the United States Steamboat Inspection Service at Norfolk, Va., succeeding Colonel John W. Oast, who has resigned after thirty years' service.

Harry S. Lord, for twelve years assistant inspector of the United States Steamboat Inspection Service at Seattle, Wash., was recently appointed inspector of this district, succeeding R. A. Turner, who was killed in an automobile accident.

R. P. Schwerin, who has been general manager of the Pacific Mail Steamship Company since 1891, has been appointed vice-president and general manager of the Associated Oil Company, controlled by the Southern Pacific Company.

W. R. Haynie, manager of Bolinders Company, New York, recently sailed from New York for Stockholm to visit the works of the J. & C. G. Bolinders, Ltd., in order to increase the facilities for delivering marine oil engines in America.

H. C. Fletcher has been appointed chief draftsman in the hull division at the New York Navy Yard, Brooklyn, N. Y. Mr. Fletcher was formerly in charge of the new work section in which the plan work for the new construction is handled.

OBITUARY

Nathan R. Dyer, superintendent of the Portland Shipbuilding Company, Portland, Me., died on October 30.

Michael Ratsey, the veteran yacht designer of Cowles, Isle of Wight, died at Kingston-on-Thames on October 27.

Isaac Leopold Rice died suddenly in New York on November 2, aged sixty-five years. For many years he was president of the Electric Boat Company.

Herbert Barber, president of Barber & Co., Inc., New York, and one of the best known shipping men in the United States, died recently in New York of pneumonia, aged sixty-eight.

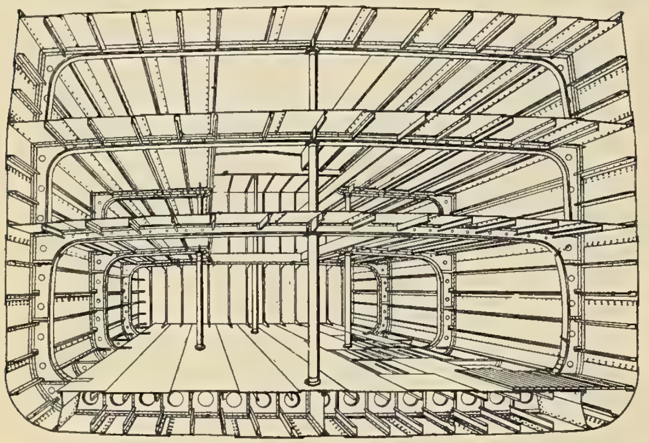
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,147,732. METHOD OF BUILDING LONGITUDINAL-FRAMED VESSELS. JOSEPH WILLIAM ISHERWOOD, OF MIDDLESBROUGH, ENGLAND.

Claim 1.—The method of erecting vessels on the longitudinal system, which consists in first bringing a plurality of the vessel's main longitudinal members in such positions that their outer surfaces will form parts of the outer contour of the vessel's completed framing; then securing to said members a plurality of the vessel's main frames



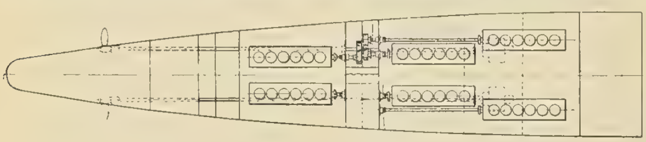
also forming parts of the outer contour of the vessel's framing, and then securing the shell plating of the vessel directly to said transverse and longitudinal members, substantially as described. Six claims.

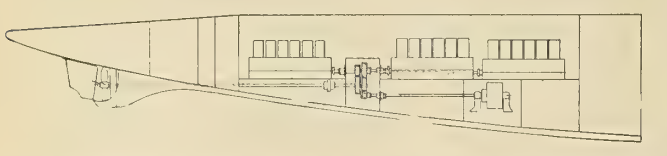
1,146,059. COLLAPSIBLE LIFEBOAT. HUGO ERNST, OF CAMDEN, N. J.

Claim 1.—A collapsible boat comprising fore and aft keel pieces, a keel strip connected to said pieces, double hinges connected to opposite sides of the keel pieces, outwardly bowed braces connected with the said hinges, a plurality of floor sections hinged to a pair of said braces and having break joints in alinement with the keel, an inflatable buoyant bag located between the floor sections and the keel, a flexible covering without and fixed to the respective keel pieces, keel and braces, and sectional hingedly connected seats pivotally secured to another pair of the braces and having break joints in vertical alinement with the break joints of the floor sections. Two claims.

1,149,373. SUBMARINE BOAT. SIMON LAKE, OF MILFORD, CONN., ASSIGNOR TO THE LAKE TORPEDO BOAT COMPANY OF MAINE, OF BRIDGEPORT, CONN., A CORPORATION OF MAINE.

Claim 3.—In a submarine boat, a gear-room built within the main hull of the boat, a propeller having the inner end of its shaft extended into said gear-room and provided with a gear-wheel, a series of engines





mounted within the boat, each having its power shaft extended into said gear-room and provided with a driving gear, a motor mounted within the boat having its shaft also extended into said gear-room and provided with a driving gear, and means for adjusting said driving gears independently into and out of mesh with the gear-wheel of the propeller shaft. 11 claims.

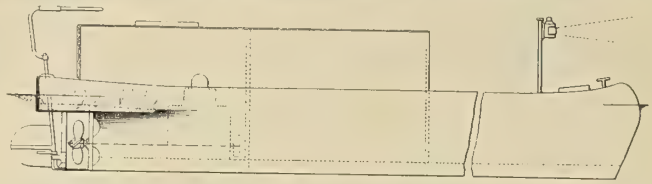
1,131,764. SOUNDER FOR SUBMARINE SIGNALING. ROBERT L. WILLIAMS, OF NEWTON, MASS., ASSIGNOR TO SUBMARINE SIGNAL COMPANY, OF WATERVILLE, MAINE, A CORPORATION OF MAINE.

Claim 1. A sounder for submarine signaling comprising a liquid-filled tank, two concentric members submerged therein, one member being within the other, the inner member being chambered, each member having ports, the ports of one member being located to register with the ports of the other member, one of said members being adapted to be rotated with relation to the other member, said ports being located on opposite sides of said members whereby when said ports register the pressure within said members will be released in opposite directions. Ten claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

20,243/14. IMPROVEMENTS IN SHALLOW DRAFT BOATS. A. H. WHITE, OF SUFFOLK HOUSE, CANNON STREET, LONDON.

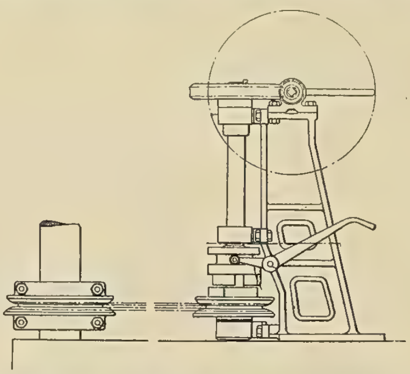
The invention relates to shallow draft boats, such as barges or canal boats, and has for its object to provide a construction of hull which results in the attainment of an increased speed and efficiency, and incidentally a prevention or diminution of wash. The underside of the



counter of the hull of the boat is formed with a ridge or projection, the said ridge extending around the outer edge of the said counter, as the propeller rotates, the water partly comes into contact with the ledge formed by the ridge or projection, and is held or piled up to a sufficient extent to prevent the formation of the partial vacuum, incidentally preventing or greatly diminishing the wash, which is of great value.

24,694/1914. TURNING-GEAR FOR SHIP'S DAVITS. H. LAING AND SIR J. LAING & SONS, LTD., DEPTFORD YARD, SUNDERLAND, DURHAM.

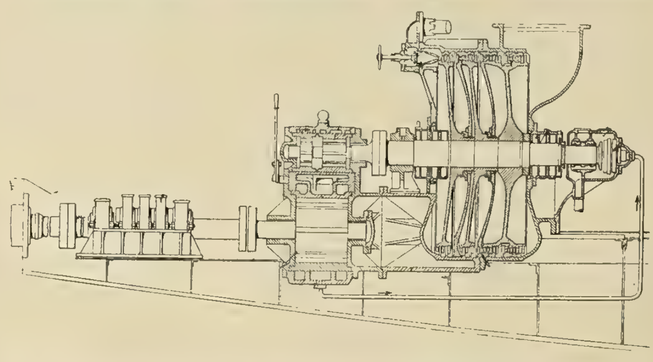
Claim.—According to this invention there is provided a separate turning gear for each davit, each gear comprising a rotated shaft mounted in bearings supported by a frame on the deck of the ship adjacent to



the davit, a chain wheel loosely mounted on said shaft, a chain wheel secured to the stem of the davit, a chain passing around said wheels, and means whereby the chain wheel on the shaft can be clutched thereto when desired so that, by rotating said shaft, the motion thereof will be communicated to the davit to turn same.

21,606/14. A HYRAULIC TRANSFORMER FOR SHIP PROPULSION BY MEANS OF STEAM TURBINES. H. LENTZ. 18, BORNIMERSTRASSE, BERLIN-HALENSEE, GERMANY.

This invention relates to a device for relieving or balancing the primary shaft in ship propulsion, with a hydraulic transformer inserted between the shaft driven by a steam turbine and the propeller shaft. By means of this transformer the speed of the propeller shaft can be modified, without altering the number of revolutions of the engine shaft. The transformer used is a hydraulic gear, consisting of valveless pumps,



one set of which is driven from the turbine shaft, while the other, or motor set, drives the propeller shaft. The set of pumps mounted on the turbine shaft and the set of motors mounted on the propeller shaft, are arranged to act at one side, and in such a manner, that during the transmission of power within the gear, there is produced a pressure tending to raise the primary shaft so that the latter is completely, or for the most part, balanced. The turbine shaft further balanced in the longitudinal direction by connecting the pressure chamber of the gear by means of a pipe to the end of the steam turbine shaft, which is enclosed at the back in the form of a piston, so that the hydraulic pressure transmitted to that point acts in opposition to the longitudinal thrust produced by the steam pressure.

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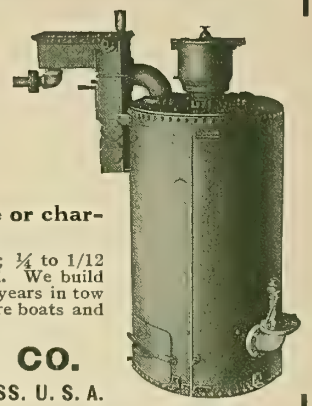

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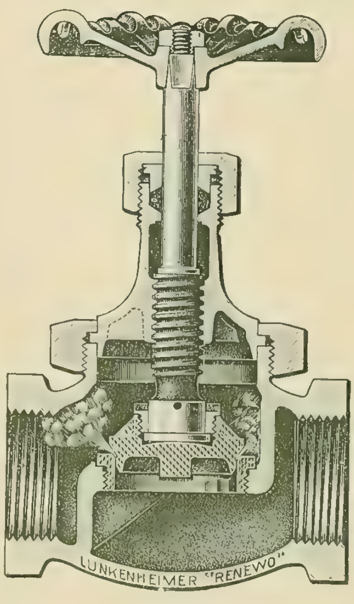

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International Marine Engineering

JANUARY, 1915

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International Marine Engineering *is one of the original members of the Audit Bureau of Circulations.*

3,900 copies of this issue were printed.

TRADE PUBLICATIONS.

AMERICA

Naval architects and engineers should include in their files a copy of the new and finely illustrated catalogue No. 10-A, giving a description of the new Seabury safety watertube boilers for both stationary and marine service. This book describes the boilers in detail as to construction and operation. A large number of illustrations show stationary installations as well as vessels of navy, commercial and pleasure types, in which Seabury motive power has been installed. These boilers are built by the Gas Engine & Power Company and Chas. L. Seabury & Company, Con., of Morris Heights, New York City.

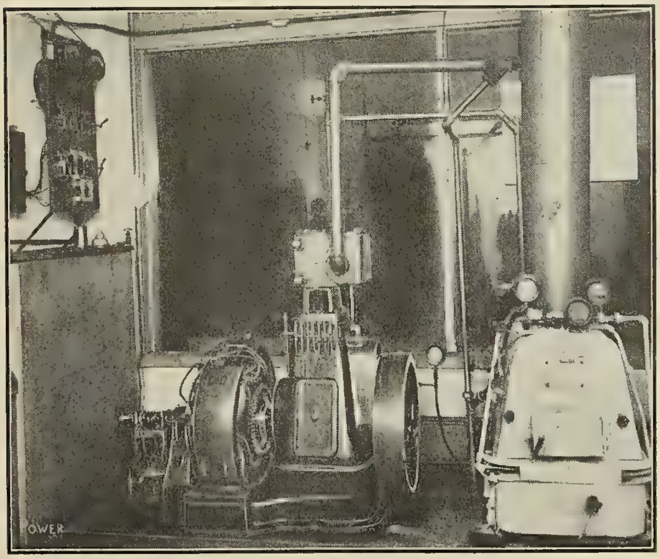
The Coen double-tip burner is described in Bulletin C just published by the Coen Company, 112 Market street, San Francisco, Cal. "There is a crying need for a flexible mechanical oil burner. By flexible we mean a burner that can produce an operating fire or a pilot fire at the will of the fireman, and change from one fire to the other instantly without extinguishing the flame, altering the oil pressure or impairing the quality of the flame. The common method of taking care of a fluctuating load by cutting burners out and then relighting them is crude; it is slow, is injurious to the furnace and increases the opportunities for furnace explosions and flare backs. If you have ever been in the fire-room of an oil-burning steamer when the ship was maneuvering in a fog, making a landing or operating under any conditions where a full head of steam was necessary, and bells for different speeds ahead or astern were sounding in the engine room, you have seen firemen running up and down in front of the boilers with lighted torches in their hands, now cutting out burners, now relighting them. Sometimes they don't light readily—the burner tip has carbonized during its temporary shut down—it has to be changed for a clean burner. Sometimes the fireman considers that the furnace is hot enough to ignite the burner without a torch, and he opens the burner; if he has guessed wrongly he is liable to experience a flare-back with disastrous results. All of these difficulties are overcome by the use of the Coen double-tip mechanical burner. With this burner the fireman has at his immediate command, not only means for regulating the size of his operating fire, but means whereby he can instantly substitute a pilot light or stand-by fire and vice versa, with one quick turn of the burner valve wheel."

"Why Load Your Ship to Her Marks by Guess Work?" is the question asked in the front of the new catalogue just issued by The McNab Company, Bridgeport, Conn. This catalogue is devoted to an illustrated description of the McNab improved draft gage, and the "Foreword" reads as follows: "Among the few articles of manufacture that have survived the changes wrought by the last hundred years—the method of trimming and loading a ship to her marks—has come down to us less changed than other. With one conspicuous exception—The "McNab" Improved Draft Gage—there are no better methods to-day of trimming and loading a ship than in the old days. You know that the principal earnings of a cargoed ship depend entirely upon the amount she carries. Your failure to heed this means financial loss in these ways: In many waterways the draft of ships is subject to critical government inspection, any excess of the prescribed limit subjects the owner to a heavy fine, while just one hard rub of the ship's bottom often results in dry docking, with its attendant expense and loss of earnings. Again, failure to load to a certain limit means an enormous loss in cargo revenue. Many ships must load in the open, where a considerable amount of seaway is encountered. Under these conditions loading with any degree of accuracy is out of the question. A ship, in order to make a safe and economical trip, must be in proper trim. This requires the utmost care and skill, which is seldom acquired with the present methods of loading. How are a ship's marks read at the present time? The officer in charge is forced to be dependent upon the accuracy of a subordinate, who must go over to the side to read the marks at stem and stern. You'll agree that this is very crude and inaccurate. The present era has literally changed the face of the world. What a few years ago was considered phenomenal, is to-day unnoticed, or else forgotten. Science has superseded theory—knowledge has taken the place of belief. In all lines of manufacture an evolution has occurred. Intricate and clumsy machinery has given place to swift and simple appliances. Many methods and materials have been entirely discarded. The economy of the world to-day demands that which consumes the least space, time and material. The old methods of reading a ship's marks are an inheritance from the past—inaccurate—inconvenient. With the best of conditions when reading, an error of 1 inch is usual, an error of 3 to 4 inches is common. A difference of an inch, according to the size of the, makes a loss in cargo earnings of from 50 tons! Think of that!"

Dixon's boiler graphite, described by the Joseph Dixon Crucible Company, Jersey City, N. J., in booklet No. 75, is stated by the manufacturer "to reduce fuel consumption, prevent the hardening of scale, give to the surface of the boilers a smooth polish, prevent pitting and make the removal of scale easy by a gentle, mechanical action."

"Ships' Ventilators" is the title of a circular issued by the Sub-Target Gun Company, 381 Congress street, Boston, Mass. "The usual type of ship ventilators are the 'spoon' and 'mushroom.' In the 'spoon' type the air is caught and forced by the movement of the vessel or the velocity of the wind into the interior spaces which are to be ventilated. Where the "mushroom' type is used the air is sucked in. Under certain conditions all the types of ventilators in common use are ineffective to prevent the admission of spray, rain or seas. Accordingly, various means are adopted for closing off the air duct. These comprise unshipping the ventilator stack, covering the opening with plates, etc. Under these circumstances, spaces designed to be supplied with fresh air are often practically sealed for long periods, and until the conditions below decks become intolerable, and such that only those who experience them can best describe them. In order to shorten the period when the ventilated spaces must be sealed, there is an inclination to defer closing off ventilators until such time as to make the storm-swept weather deck a most dangerous place to which to send seamen to unship stacks and fit covers or hatches. These operations have often been attended with casualties and the loss of fittings which leave openings, endangering the safety of the vessel. In order to provide something of a remedy, covers are sometimes fitted to the duct inside the vessel. Such covers are wet and troublesome, dripping water while in place and deluging the room when opened. They also tend to change the direction and otherwise reduce the air efficiency. The improved draft controlling ventilator catches the air and forces it into the ventilated space. Self-draining is a form of ventilator duct cover which is always ready for instant use. Can remain open until the last moment of necessity. Can be opened as soon as weather stress abates or as it appears to abate. Can be instantly operated from within the vessel. Forms no effective obstruction to air currents, as when open it stands in a vertical plane. Whenever open is perfectly dry, shedding water into drain above the deck line. Provides an effective catch for air with ventilator stack removed. A watertight cover for the opening if the stack is carried away. Can be made in composition or other metals and fitted to old work as well as new."

Marine refrigeration is entered into with much detail in a number of circulars published by the Brunswick Refrigeration Company, 130 Jersey avenue, New Brunswick, N. J. "The proper preservation of the ships's stores is an item which, in the past, has not received anything like the consideration due this most important subject, although it is now being realized more and more that is economical to supply the crew as well as the passengers with fresh food at all time. The cooling of refrigerators with ice aboard ship always has been and always will be an item of very great inconvenience and expense, which the steward's department and the shipowner both wish might be much reduced. The cost of the ice alone is especially high in tropical countries, as is also the cost of labor in getting the ice from the dock into the refrigerator on board the ship, to say nothing of the loss by melting. In a refrigerator cooled by melting ice there are always dampness and unsanitary conditions to contend with. The meat stored becomes slimy, necessitating trimming, which item alone has been found to amount, in the case of a coast steamer of 7,000 tons displacement, to between $1,300 and $1,400 in one year. The deterioration of the ice-box, due to the abuse in filling, necessitates frequent repairs. The varying and uncertain temperatures produced by melting ice cause the goods stored to become unfit for use in a short time. A marine type refrigerating plant will cut the cost of refrigeration to practically nothing, the steam required amounting to but little, and the cost of oil, ammonia and repairs amounting to still less. The dry, sweet, pure air, and the uniform low pressure necessary for the proper preservation of foodstuffs, can be obtained in no other way than by the installation of a refrigerating plant. The Brunswick Refrigerating Company, 130 Jersey avenue, New Brunswick, N. J., has for a number of years made a specialty of marine refrigeration in all its branches. At this writing over two hundred vessels have been equipped with Brunswick plants. Any vessel from a tugboat or yacht to a large passenger-carrying steamer can be equipped with a Brunswick refrigerating plant for ship's stores or cargo storage. The initial cost is not great, and the average plant can be installed in a very few days' time without interfering with the movements of the vessel."



Electric equipment for marine service is described in a number of catalogues published by the General Electric Company, Schenectady, N. Y. "The value of the searchlight is well known. It may save the entire cost of your electrical equipment in a single hour. Electric lights, electric power and electric devices are more convenient, more reliable, and hence less expensive than other methods in a long run at sea. Passenger lines increase traffic by adding searchlights, Edison Mazda lamps, fans, heaters, etc. A freighter can increase yearly receipts by reducing its time in dock by motor loading and by having a good light at night with the G-E searchlight. The General Electric Company makes many other products especially designed for marine work. All of these are described and illustrated in separate catalogues.

Roto tube cleaners are described in Catalogue No. 41, issued by the Roto Company, Hartford, Conn. The following description is given of the Roto type A. D. tube cleaners: "Roto type A. D. air or steam-driven tube cleaners need no introduction. They are in general use all over the world, wherever tube cleaners are used. The Roto positive balanced motors, with Roto improvements in safe and rapid cleaning heads, have completely revolutionized tube cleaning. They have replaced the old turbine or paddle-wheel cleaners in the largest and best managed power plants. The list of users includes the best and best known, the most up-to-date and best managed power plants in the country. In the large power plants of the great traction companies, railroads, mills, mines and factories, where hard scale forms rapidly, our Roto positive balanced motors have replaced the old water-driven turbines. The new Roto is cleaning boiler tubes in from one-tenth to one-quarter the time formerly required. The Roto is doing the work better, getting all the scale, without injury to the boiler tube, and with less cost for power. No scale is too hard or heavy for Roto type A. D. cleaners. The retubing of many boilers and purchase of thousands of new tubes have been avoided by the adoption of Roto type A. D. cleaners after all others failed."

"A Close Call" is the title of the picture printed in several colors on the 1915 catalogue just issued by the Lukens Iron & Steel Company, Coatesville, Pa. This picture is a reproduction of the original painting by James G. Tyler. "The sea is Mr. Tyler's favorite subject, and he has earned the honor of being called one of its best interpreters. The sea appeals to him as a vast living thing, and he has followed its mood with a deep-seated affection that makes itself apparent in all his work. He has chosen for his picture a day of high wind and tumbling surf. He has found the ocean in an hour of rough play, and he has pictured it in a dramatic moment, when the sturdy schooner, driven from its course, has just cleared a rock of formidable proportions and is headed for deep water. It was a 'close call' for the vessel, for, at one moment, she evaded utter destruction only by a few rods. The picture has a thrill for all who knows the dangers of the sea. We appear to be in the midst of a tumult of water. The white horses of the surf dash up in columns, rearing their heads high as they cast themselves upon their old-time granite foes. Back of this great cauldron of seething water lies the sombre, shadowy stretch of the boundless sea. Above, the clouds, gray and threatening, scud across the sky. It is an inspiring scene of cosmic warfare full of stern and splendid beauty."

"Small Power-Driven Compressors" are the subject of Bulletin 34-S, just issued by the Chicago Pneumatic Tool Company, Fisher building, Chicago, Ill. "The ever-increasing number of applications of compressed air in the many fields where it may advantageously and economically employed, have created a demand for small pneumatic plants, which shall be at once simple, compact, substantially constructed units, requiring a minimum amount of attention. We were among the first to recognize that this demand for small power compressors could only be satisfactorily supplied by a company of wide and unquestionable experience and prestige in the art of compressor building, and the success attending the introduction of our line of small machines has justified our initiative in offering them. These compressors supplement our line of over four hundred sizes and types driven by steam, belt, electricity, gas, gasoline, fuel oil and water power, and round out a variety of machines adapted to every possible condition or requirement. Special descriptive bulletins are devoted to each of the various types of compressors that we manufacture, and will be sent upon request addressed to our main offices or nearest branch, as given on the last page of this bulletin. We illustrate and list in the following pages small power compressors particularly suited to the requirements of garage owners, stone cutters, monumental works, electric stations, spraying outfits, and the countless applications to which compressed air lends itself."

"Are You Troubled with Scale?"—This is a question asked by the Joseph Dixon Crucible Company, Jersey City, N. J. The company has issued booklet No. 75 on "Graphite for the Boiler," which describes in full the advantages of using Dixon's graphite for the prevention of scale.

The 144-page "Monthly Journal and Stock List," which is published by Joseph T. Ryerson & Son, Chicago, Ill., should be in the hands of every user of boiler shop tools and machinery of any description whatever. Messrs. Ryerson & Son maintain three great warehouse plants in New York, Chicago and St. Louis, and offer everything in iron, steel and machinery for immediate shipment.

Portable electric drills are described in a circular just issued by the Independent Pneumatic Tool Company, 1307 Michigan avenue, Chicago, Ill. According to this manufacturer "a notable step forward in electric drill construction is shown in the 'Thor.' Progressive users, always on the alert to secure the latest improved equipment, will recognize the many new features which produce the highest efficiency and greatest economy. Made in various sizes."

Lagonda multiple strainers are described in Catalogue R-2, published by the Lagonda Manufacturing Company, Springfield, Ohio. "Nowadays it is found necessary to subject the present boiler installation to sudden overloads and higher continuous loads, so that in many cases the capacity of the boilers has been increased by installing condensers. In the case of steam turbines designed for high vacuum, considerably more power is obtained and about 40 percent less steam is consumed per horsepower-hour when running the turbine condensing over running it when exhausting it to the atmosphere. In the cases of reciprocating engines, 25 to 40 percent of the load is carried by the vacuum. In order therefore to secure and maintain high vacuum to enable boilers, turbines and engines to hold up their loads, the condensers must be kept clean and supplied with a constant uninterrupted flow of cooling water. Besides protecting condensers, the use of a Lagonda water strainer reduces pump troubles. In the case of reciprocating pumps it prevents solid matter from scoring the cylinders, and prevents the clogging of valves and resulting leakage. In the case of centrifugal pumps, a Lagonda strainer prevents such foreign matter from becoming lodged between the impeller blades."

Wolverine engines, their use on ships of many types throughout the world, are described in illustrated folders published by the Wolverine Motor Works, Bridgeport, Conn. Among the interesting illustrations shown is one of the tug *Viking* equipped with a 27-horsepower Wolverine engine and used for towing logs from villages along the Arracan coast to Bassein, India. The *Viking,* according to the Wolverine Motor Company, has towed four heavy cargo boats loaded with 200 tons against a 2-knot current.

"Durable" wire rope for mooring, towing hawsers, ship's rigging, and all similar purposes, is described in a catalogue just issued by the Durable Wire Rope Company, 93 Pearl street, Boston, Mass. The manufacturer states that this rope is made of selected steel, and that each strand is separately served with especially prepared hemp marlin. The rope is also stated to combine the pliability and wearing service of hemp or manilla ropes with the strength of ordinary wire rope, avoiding the disadvantages of both, and being more durable and economical than either.

The Ohio grease lubricator and Ohio cylinder grease are described in an illustrated circular published by the Engineering Supply Company, 2238 North Ninth street, Philadelphia, Pa. A full description is given of these products, which are sent on trial. "The Ohio grease lubricator atomizes or sprays Ohio cylinder grease into the cylinder of an engine or pump. Ohio cylinder grease consists almost wholly of high-grade cylinder stock refined from Pennsylvania crude. It does not contain neutral oils or wood grease. It does not contain any alkali or saponaceous matter. When Ohio cylinder grease is used we guarantee a saving of at least 25 percent. In many cases we have effected greater economies. We offer to prove this saving before asking a prospective purchaser to spend a cent. The ice plants and other establishments where trouble has been caused by oil going over with exhaust this trouble has been entirely removed by the use of Ohio cylinder grease. The Ohio grease lubricator is never sold. It is always loaned. No contract to purchase a specified quantity is required. All we ask is that no other lubricant be fed through this lubricator. We will send Ohio grease lubricator and 25 pounds of Ohio cylinder grease on trial. If a saving of 25 percent over other forms of lubrication is effected, grease to be paid for. If saving of 25 percent is not effected, return lubricator and balance of grease to us."

"Ice Making and Refrigerating Machinery" is the title of the "General Catalogue" which has just been published by the York Manufacturing Company, York, Pa. The company's line of ice-making and refrigerating machinery is fully described and illustrated in this catalogue, which also contains a long list of users of the York vertical single-acting inclosed type ice making and refrigerating machinees.

"Williams Steam Specialties" are the subject of a very complete cloth-bound catalogue of 320 pages and several hundred illustrations which has just been issued by the D. T Williams Valve Company, Cincinnati, Ohio. A copy of this catalogue should be in the hands of every user of such specialties. It describes in detail a very complete line of brass and iron stop and check valves, gate valves, steam cocks, water gages, gage cocks, brass fittings, lubricators, oil and grease cups, steam traps and separators, etc.

"Asbestosteel" is the title of an unusually well-illustrated and printed booklet which is being distributed by the Asbestos Protected Metal Company, Beaver Falls, Pa. "Asbestosteel," which is stated to be especially useful for use on steamship docks and piers and on board ship, is described in part as follows: "Asbestos-protected metal, being a permanent material, presents possibilities absolutely new and hitherto unapproached by any sheet metal. Not only does it displace sheet steel from the field considered its own, but when combined with concrete and other similar materials, it can be used to great economic advantage in the highest class of permanent structures."

"A Few of the Tools Manufactured by the Stow Flexible Shaft Company, Binghamton, N. Y.," is the title of a circular published by the Stow Manufacturing Company, Binghamto, N. Y. "The Stow line of portable tools is the most complete on the market. They are furnished both belt and electric driven. Much time has been expended in the design of these tools to secure the maximum of power to size. Several of our designs are constructed to save floor and bench room, same being of the suspended type, thus putting them out of the way in a safe place when not in use and always in arm's length of your operator. Write us your requirements. We have a tool for your work that will save time and cut your cost of operation."

The Rippley Mfg. & Steel Boat Company, Grafton, Ill., has published an illustrated catalogue describing its line of motor boats, cruisers, K. D. sectional steel hulls, barges, ferryboats, life rafts, hunting, fishing and pleasure boats.

"Steam Boilers and Boiler Feed Water" is the title of a booklet which has just been issued by the American Boiler Life Company, 19 North Market street, Boston, Mass. Our readers who are interested in the subject of "boiler feed water" should write for a free copy of this booklet.

"Seabury" watertube boilers are described in Catalogue 10-A, just published by the Gas Engine & Power Company and Chas. L. Seabury & Company, Con., Morris Heights, New York City. The catalogue states that these boilers are built for hard usage and that there are no screw joints in the generating tubes. They are made for all pressures up to 400 pounds, and minimum weight and space—maximum power are guaranteed.

Locomotive cranes are described in a catalogue published by the Link-Belt Company, Chicago, Ill. "A Link-Belt crane is an all-around machine for general work about any plant. It may be arranged to handle hook block, self-filling grab bucket, drag-line bucket, electric-lifting magnet, or equipped with special boom for steam shovel attachment and pile driver."

Economical freight handling is discussed in Bulletin No. 80115, just issued by the Sprague Electric Works of the General Electric Company, 527 West Thirty-fourth street, New York. The catalogue states that by the use of Sprague electric freight trucks, freight is easily loaded and unloaded and congestion reduced to a minimum. Grades as high as 25 percent are negotiated without difficulty under full loads.

The Starrett speed indicator is one of a large line of engineering specialties manufactured by the L. S. Starrett Company, Athol, Mass., and described in Catalogue 20-L which the company has just published. In describing this indicator the catalogue states that for taking speed tests on engines, generators, turbines, motors, line shafting or any machinery, the indicator is the simplest and most accurate instrument of the kind made. It is said to be especially valuable in taking speeds when computing engine horsepower, etc. It is made in three styles. Prices, $1.00, $1.50 and $3.00.

A wall calendar of very convenient size and shape will be sent free to any of our readers who will write the Pocahontas Fuel Company, 1 Broadway, New York, and ask for it. The Pocahontas Fuel Company is the miner, shipper and exporter of "Original Pocahontas" coal, and states that it is the largest producer of smokeless coal in the United States. Latin American, West Indian and European coal consumers are especially invited to correspond with the company.

"S & K Evaporators and Distillers" are the subject of Catalogue 10, Section D E, which has just been published by the Schutte & Köerting Company 1253 North Twelfth street, Philadelphia, Pa. "It is unnecessary, in the present stage of marine engineering, to point out the advantage of using evaporators, as, immediately on their introduction on the market, about thirty years ago, their utility and economy was recognized. The question for the marine engineer to decide now is which evaporator to purchase, and in making a decision he should consider efficiency, capacity, ease in handling and cleaning, freedom from priming, simplicity of construction, strength and durability, weight and space occupied, price. These various points have been given the closest attention by our engineers in designing and building; the result is the evaporator which we are now putting on the market."

S & K spiral corrugated film specialties are described in Catalogue 10, Section F, just issued by the Schutte & Köerting Company, 1253 North Twelfth street, Philadelphia, Pa. "The prime feature of our boiler feed water heater is the concentric spirally corrugated tubes. This construction, besides constantly agitating the water and so preventing the formation of cold cores, keeps the water in a thin film between two heated copper surfaces. This gives an exceedingly high rate of heat transmission, far exceeding anything that has ever been accomplished. Experience has shown that the formation of scale is so limited as to be negligible. This is due to the fact that there is a peculiar expanding and contracting movement constantly taking place in the tubes which breaks off the scale as it forms, and the high velocity of the water scours out the film spaces. Not only does this heater save weight and space by its greater heat transmission per square foot, but by inserting one tube inside the other we get almost two square feet to one in the same space where the tubes are single."

"Scientific Facts" is the title of a profusely illustrated 136-page catalogue just published by the Champion Rivet Company, Cleveland, Ohio. This is the fourth edition of the book, which is an invaluable one to all users of boiler, structural and ship rivets. A copy will be sent absolutely free to any of our readers who will ask for it. The table of contents of the book is very comprehensive, comprising a report on the physical and chemical tests made on "Victor" steel rivets; a letter on government tests by Oscar Textor; a report of analyses by the same man; standard specifications for boiler rivets; standard specifications for boiler rivet steel; standard heads for small rivets; standard heads for large rivets; special heads for rivets; dimensions for standard heads; weights of rivets; coupler and air brake pins, and essays on "How to Heat and Drive Rivets Satisfactorily."

BUSINESS NOTES

AMERICA

The International Oxygen Company, Newark, N. J., writes International Marine Engineering that the I. O. C. oxy-hydrogen plant, with which the Edison works (recently partially destroyed by fire) was furnished, has remained intact, and that these gases are being used in the storage battery building, which, fortunately, was not touched by the fire.

"Four thousand engines built in ten years and only one oiling a year for each." This is a remarkable statement, but the American Blower Company, Detroit, Mich, writes us that ten years ago the first ABC self-oiling engine was built, and that since that time more than four thousand have been put into service. "Most of these ABC engines are still in service—some of them have needed only yearly replenishments of oil."

Sixty-eight prosperous years for the William Powell Company. The William Powell Company, Cincinnati, Ohio, asks us to call attention to the fact that it is now 68 years old. Its advertisement on page 4 of this issue contains sixty-eight stars. The company manufactures a complete line of globe valves, angle valves, cross valves, gate valves, check valves and other marine specialties, and has made them for sixty-eight years.

THE DIAMOND POWER SPECIALTY COMPANY, 58 First street, Detroit, Mich., has received a contract from the Navy Department calling for seven of its soot cleaners for use in Babcock & Wilcox boilers at the Washington navy yard. One soot cleaner was installed and thoroughly tested. After it was found satisfactory the Navy Department placed an order for six more.

BIG PIPE COVERING CONTRACT.—The pipe insulation contract for the new Utah State Capitol at Salt Lake City was recently awarded to the H. W. Johns-Manville Company, New York. The high-pressure pipes will be covered with J-M Asbesto-Sponge Felted Pipe Covering, a product made up of laminations of felt composed of asbestos and finely ground sponge. The materials being naturally cellular, they form the basis for the claim that this covering confines more "dead air" cells than any other covering, and therefore possesses higher heat-insulating value. The heating pipes will be covered with J-M Asbestocel Pipe Covering, which is built up on the arch principle. Sealed air channels run around the pipe instead of parallel with it, thus preventing the circulation of air and consequent heat radiation.

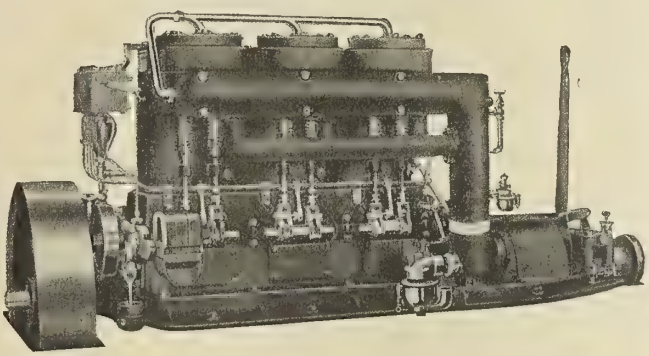
"PALMETTO" PACKING ON BRITISH BATTLESHIPS.—Among the other well-known battleships belonging to the British navy equipped with Palmetto packing is the H. M. S. *Thunderer*. Palmetto packing was selected for her trial trip because, according to the manufacturer of this packing, Greene, Tweed & Company, 109 Duane street, New York, and Queen Ann's Chamber, Westminster, S. W., "Palmetto packing has a well-established reputation for great lasting qualities under the most exacting conditions, especially high-pressure superheated steam." A free sample of Palmetto packing will be sent to any engineer, architect, shipbuilder or ship owner upon request.

GREAT LAKES NAVIGATION, SEASON OF 1914.—Unsatisfactory, unprofitable, unpleasant are some of the terms applicable to the business of vessel men on the Great Lakes for the season of 1914. From start to finish each succeeding month proved disappointing at its close. Shipments of iron ore from Lake Superior were about 18,000,000 tons less than in 1913, and the smallest of any season since 1908. The season closed officially at midnight November 30, when all marine insurance except on vessels under way from one port to another and several loading grain on Lake Superior just managed to clear before the midnight hour of expiration. A few wild carriers were operated and a few boats in regular trade until December 10 owing to unusually mild weather from November 29 to December 10. Offers of 2 cents per bushel on grain out of Duluth for first days of December were rejected. Quite a number of boats will hold cargoes at upper lake ports until spring. About the last successful wrecking operation was the getting afloat of the steamer *Lehigh* on December 3 by the Reid Wrecking Company from a point near Manistique on Lake Michigan, where she had run ashore. The salvage of the big steel steamship *Howard M. Hanna*, on Lake Huron, where she was blown to pieces on November 9, 1913, was a Reid job. This steamer has since passed into hands of Canadian owners and been completely rebuilt by the Collingwood Shipbuilding Company. The number of lives lost on the Great Lakes, the number of vessels lost and value of cargoes are small as compared with the record of the season of 1913. Sanitary disposal of sewage and garbage from lake vessels, to prevent contamination of waters from which all the big lake cities get their supply, is a problem receiving much attention, and much in "safety first" education and methods has been accomplished the past season. The Welfare Plan, aiming at the bettering of all conditions and regulations of lake navigators and seamen is working more and more satisfactorily, and the savings bank plan has made hundreds of saving men out of formerly financially impecunious ones. Vessels lost number about twenty-four steamers, tugs, schooners and barges, on seven of which about eighty lives were lost. The steamer *C. F. Curtis* and her barges *Marvin* and *Peterson* were lost with every soul aboard, numbering thirty-four. The steel steamer *Benj. Noble* foundered with her entire crew of twenty. The Canadian lighthouse steamer *Montmagny* was lost in a collision with the steamer *Lingan* 25 miles below Quebec, Canada, and fifteen lives of people on the *Montmagny* were lost. The Canadian schooner *William Jamieson* foundered on Lake Ontario with a loss of six lives. Ten of the vessels lost were destroyed by fire. The loss of the steamer *Empress of Ireland* by collision below Montreal in the St. Lawrence River, with a loss of 965 lives, while close at hand cannot be classed among lake vessels. Not a life was lost aboard of a passenger vessel in the entire season on the Great Lakes.

TRADE PUBLICATIONS

GREAT BRITAIN

"Recent Developments in Machine Stoking" is the title of a 40-page catalogue published by Ed. Bennis & Company, Ltd., Little Hulton, Bolton. "The Bennis patent improved smokeless chain grate is applicable to any watertube boiler or to return-tube boilers—where the fire is under the boiler shell and the flame returns through the tubes—to brewers' coppers and



MARINE SOCIETIES.

AMERICA.

AMERICAN SOCIETY OF NAVAL ENGINEERS
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
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29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE
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Grand Doorkeeper—A. J. Ross, Halifax, N. S.
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GREAT BRITAIN.

INSTITUTION OF NAVAL ARCHITECTS
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND
39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS
Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORP.
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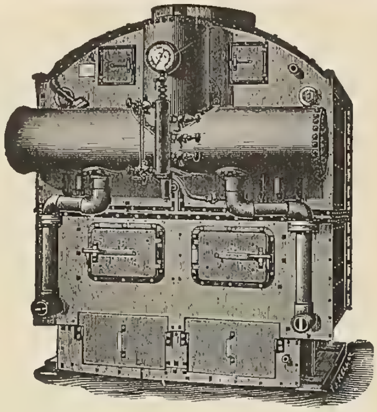
similar furnaces. One of the principal advantages of this type of grate is that a very large grate area can be obtained under a boiler, much larger than could be dealt with by hand-firing. The economies to be obtained over hand-firing vary from 10 percent upwards, for not only is a higher actual boiler efficiency obtained and maintained, but the stoker is generally capable of burning a fuel cheaper in initial cost. We are always pleased to test samples of fuel submitted by prospective clients in our laboratories, and to give definite figures as to what may be expected as to economies and evaporation in each individual case. The Bennis chain grate with the patent halved link was the first chain grate capable of satisfactory burning fine slack coals."



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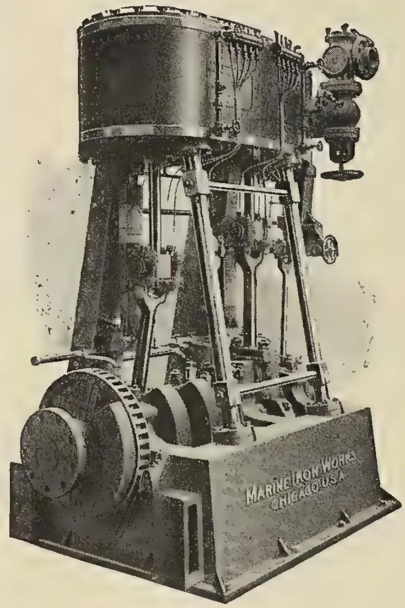

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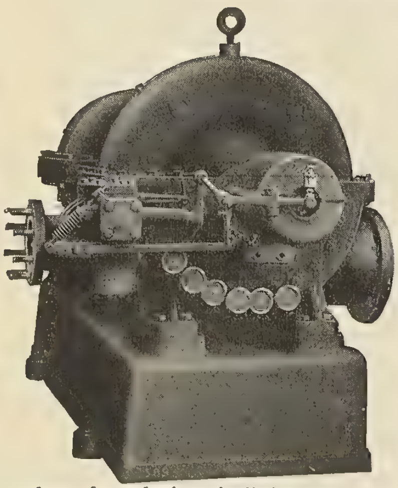

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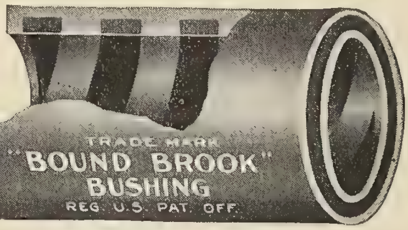

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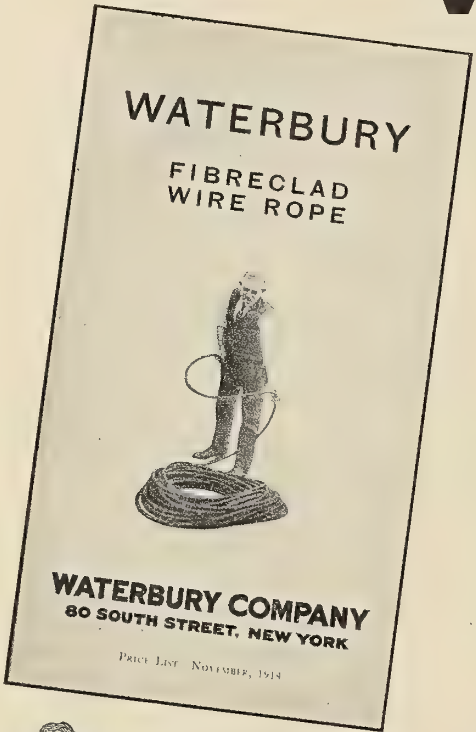

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Fixed Carbon	74.81	per cent
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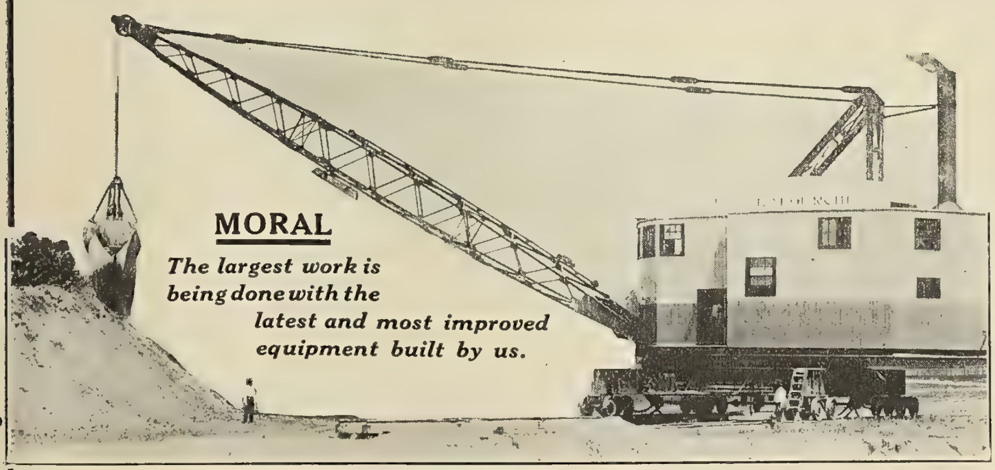

The crane shown in the illustration is owned and operated by the Lafourche Basin Levee Board. It is fitted with an 88 foot boom and 2 1-2 yard Hayward Orange Peel Bucket.

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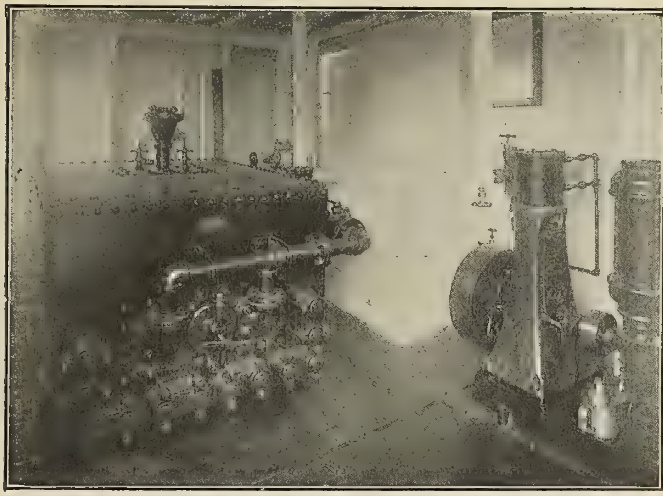

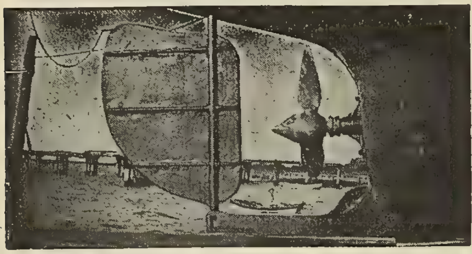

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Link-Belt Co., Chicago, Ill.
McMyler-Interstate Co., The, Cleveland, Ohio.
Otis Elevator Co., New York.
Sprague Electric Works, New York.

FRIGIDOMETERS.
McNab Co., The, Bridgeport, Conn.

FROSTPROOF COVERINGS.
Ferdinand, L. W., & Co., Boston, Mass.
Johns-Manville Co., H. W., New York.

FUEL ECONOMIZERS.
Griscom-Russell Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

FUEL OIL BURNERS.
Schutte & Körting Co., Philadelphia, Pa.

FURNACE FRONTS—MARINE AND STATIONARY.
Continental Iron Works, The, Brooklyn, N. Y.

FURNACES—Also see CORRUGATED FURNACES.
Continental Iron Works, The, Brooklyn, N. Y.

FURNACE BRIDGE WALLS
Wager, Robert H., New York.

FUSIBLE PLUGS.
- Griscom-Russell Co., New York.
- Johns-Manville Co., H. W., New York.
- Lunkenheimer Co., Cincinnati, Ohio.
- Williams Valve Co., D. T., Cincinnati, Ohio.

GALLEYS—See RANGES.

GAS BLOWERS AND EXHAUSTERS.
- American Blower Co., Detroit, Mich.
- Schutte & Körting Co., Philadelphia, Pa.
- Sturtevant Co., B. F., Hyde Park, Mass.

GASKETS—Also see PACKING.
- Griscom-Russell Co., New York.
- Johns-Manville, H. W., Co., New York.
- New York Belting & Packing Co., New York.
- Peerless Rubber Mfg. Co., New York.
- Smooth-On Mfg. Co., Jersey City, N. J.

GASOLINE ENGINES—Also see LAUNCHES AND YACHTS. KEROSENE ENGINES; OIL ENGINES.
- Bridgeport Motor Co., Bridgeport, Conn.
- Gas Engine & Power Co., and Chas. L. Seabury & Co., Consol., Morris Heights, N. Y.
- Standard Motor Construction Co., Jersey City, N. J.
- Wolverine Motor Works, Bridgeport, Conn.

GAS ENGINE SPECIALTIES.
- Lunkenheimer Co., Cincinnati, Ohio.
- National Tube Co., Pittsburgh, Pa.
- Powell, Wm., Co., Cincinnati, Ohio.
- Star Brass Mfg. Co., Boston, Mass.
- Williams Valve Co., D. T., Cincinnati, Ohio.

GAS PRODUCERS—See MARINE GAS PRODUCERS.

GATE VALVES—See VALVES.

GAUGE COCKS.
- Jerguson Gage & Valve Co., Boston, Mass.
- Lunkenheimer Co., Cincinnati, Ohio.
- National Tube Co., Pittsburg, Pa.
- Powell, Wm., Co., Cincinnati, Ohio.
- Star Brass Mfg. Co., Boston, Mass.
- Williams Valve Co., D. T., Cincinnati, Ohio.

GAUGES—See STEAM GAUGES; also WATER GAUGES.

GAUGE GLASSES.
- Jerguson Gage & Valve Co., Boston, Mass.
- Lunkenheimer Co., Cincinnati, Ohio.
- Williams Valve Co., D. T., Cincinnati, Ohio.

GENERATORS—See ELECTRIC PLANTS.

GLOBE VALVES—See VALVES.

GLUE—LINOLEUM, MARINE, SHIP, YACHT, WATERPROOF.
- Ferdinand, L. W., & Co., Boston, Mass.

GOVERNORS—See PUMP GOVERNORS.

GRABS—See DREDGING MACHINES.

GRAPHITE.
- Dixon, Jos., Crucible Co., Jersey City, N. J.

GRATE BARS.
- Griscom-Russell Co., New York.

GREASE—See LUBRICANTS.

GREASE CUPS—See LUBRICATORS.
- Albany Lubricating Co., New York.
- Griscom-Russell Co., New York.
- Lunkenheimer Co., Cincinnati, Ohio.

GREASE EXTRACTORS.
- Griscom-Russell Co., New York.

GYPSEYS.
- American Engineering Co., Philadelphia, Pa.
- Hyde Windlass Co., Bath, Maine.

HAMMERS, PNEUMATIC—See PNEUMATIC TOOLS.

HARDWARE—See MARINE HARDWARE; also CHANDLERY STORES.

HARDWOOD—See LUMBER.

HAWSERS—See WIRE ROPE.

HEATERS—BATH, LAVATORY, SHOWER.
- Alberger Pump and Condenser Co., New York.
- Sands, A. B., & Son Co., New York.
- Schutte & Körting Co., Philadelphia, Pa.

HEATING AND VENTILATING APPARATUS.
- American Blower Co., Detroit, Mich.
- Schutte & Körting Co., Philadelphia, Pa.
- Sturtevant Co., B. F., Hyde Park, Mass.

HEMP—See TWINE.

HOISTING ENGINES.
- American Engineering Co., Philadelphia, Pa.
- Hyde Windlass Co., Bath, Maine.
- Lidgerwood Mfg. Co., New York.

HOISTS, CHAIN—See CHAIN HOISTS.

HOISTS, ELECTRIC—See ELECTRIC HOISTS.

HOSE—See AIR HOSE.
- Eureka Fire Hose Mfg. Co., New York.
- Independent Pneumatic Tool Co., Chicago and New York.
- Johns-Manville Co., H. W., New York.
- New York Belting & Packing Co., New York.

HOSE COUPLING.
- Eureka Fire Hose Mfg. Co., New York.
- Independent Pneumatic Tool Co., Chicago and New York.
- National Tube Co., Pittsburg, Pa.

HOSE NOZZLES.
- Morse, Andrew J., Son, Inc., Boston, Mass.

HUMIDIFIERS.
- Griscom-Russell Co., New York.

HYDRAULIC FITTINGS.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Powell, Wm., Co., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

HYDRAULIC MACHINERY—RIVETERS, PUNCHES, SHEARS.
Niles-Bement-Pond Co., New York.

ICE DETECTORS.
McNab Co., The, Bridgeport, Conn.

ICE MACHINES—See REFRIGERATING PLANTS.

INCLINED ELEVATORS FOR DOCKS AND WHARVES.
Otis Elevator Co., New York.

INDICATOR CONNECTIONS.
Lunkenheimer Co., Cincinnati, Ohio.

INDICATORS—STEAM AND GAS ENGINE—Also see DIRECTION AND REVOLUTION INDICATORS.—Also RUDDER POSITION INDICATORS.
Johns-Manville Co., H. W., New York.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., The, Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

INDUCED DRAFT.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

INJECTORS.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., The, Wm., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

INSURANCE—MARINE AND FIRE.
Hutchinson, Rivinus & Co., New York and Philadelphia.

INTERLOCKING RUBBER TILING.
Griscom-Russell Co., New York.
New York Belting & Packing Co., New York.

IRON CEMENT.
Johns-Manville Co., H. W., New York.
Smooth-On Mfg. Co., Jersey City, N. J.

JACKS—PNEUMATIC.
Independent Pneumatic Tool Co., Chicago and New York.

JOURNAL BEARINGS—See THRUST BEARINGS.

JUTE.
Columbian Rope Co., Auburn and New York.

KEROSENE ENGINES—See also OIL ENGINES AND DIESEL ENGINES.
Standard Motor Construction Co., Jersey City, N. J.
Wolverine Motor Works, Bridgeport, Conn.

LATHES, CRANK SHAFT.
Niles-Bement-Pond Co., New York.

LAMPS, SIGNALS, AND FIXTURES.
General Electric Co., Schenectady, N. Y.
Johns-Manville, H. W., Co., New York.

LATHES, ENGINE.
Niles-Bement-Pond Co., New York.

LATHES, TURRET.
Niles-Bement-Pond Co., New York.

LAUNCHES AND YACHTS—See also SHIPBUILDERS AND DRY DOCK COMPANIES—Also PROFESSIONAL CARDS.
Bridgeport Motor Co., Bridgeport, Conn.
Marine Iron Works, Chicago, Ill.
Standard Motor Construction Co., Jersey City, N. J.
Ward, Chas., Engineering Works, Charleston, W. Va.
Welin Marine Equipment Co., Long Island City, N. Y.

LAVATORIES—FOLDING, STATIONARY, STATEROOM.
Sands, A. B., & Son Co., New York.

LAVATORY AND BATH HEATERS.
Griscom-Russell Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

LIFE BOATS AND RAFTS.
Welin Marine Equipment Co., Long Island City, N. Y.

LIFE PRESERVERS.
Ferdinand, L. W., & Co., Boston, Mass.
Welin Marine Equipment Co., Long Island City, N. Y.

LIFE-SAVING DEVICES.
Welin Marine Equipment Co., Long Island City, N. Y.

LINOLEUM CEMENT.
Ferdinand, L. W., & Co., Boston, Mass.

LIQUID GLUE, WATERPROOF.
Ferdinand, L. W., & Co., Boston, Mass.

LOCOMOTIVE CRANES—See CRANES.

LOG REGISTERS.
Nicholson Ship Log Co., Cleveland, Ohio.
Welin Marine Equipment Co., Long Island City, N. Y.

LUBRICANTS.
Albany Lubricating Co., New York.
Dixon, Jos., Crucible Co., Jersey City, N. J.

LUBRICATING COMPOUND.
Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.

LUBRICATORS.
Albany Lubricating Co., New York.
Griscom-Russell Co., New York.
Graphite Lubricating Co., Bound Brook, N. J.
Lunkenheimer Co., Cincinnati, Ohio.
Powell, Wm., Co., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

LUMBER—FIREPROOF.
Johns-Manville Co., H. W., New York.
Keyes Products Co., New York.

MACHINE SHOP.
Gisholt Machine Co., Madison, Wis., and Warren, Pa.

MACHINE TOOLS—See TOOLS, MACHINE.

MAHOGANY—See LUMBER.

MANGANESE BRONZE CASTINGS—Also see BRONZE.
Griscom-Russell Co., New York.
Hyde Windlass Co., Bath, Maine.
Lunkenheimer Co., Cincinnati, Ohio.

MAGNESIA COVERINGS.
Johns-Manville, H. W., Co., New York.

MANILA AND SISAL ROPE—See ROPE; also CORDAGE.

MARINE BOILER COMPOUNDS—See BOILER COMPOUNDS.

MARINE CABLEWAYS.
Lidgerwood Mfg. Co., New York.

MARINE ELECTRICIANS—See ELECTRIC PLANTS.

MARINE ENGINES—See ENGINES, PROPELLING.

MARINE FORGINGS—See FORGINGS.

MARINE GAS PRODUCERS.
Galusha & Co., A. L., Boston, Mass.
Griscom-Russell Co., New York.

MARINE GLUE.
Ferdinand, L. W., & Co., Boston, Mass.

MARINE HARDWARE.
Gas Engine & Power Co., and Chas. L. Seabury & Co., Consol., Morris Heights, N. Y.
Griscom-Russell Co., New York
Ferdinand, L. W., & Co., Boston, Mass.

MARINE LAMPS—See LAMPS.

MARINE RAILWAY BUILDERS—See RAILWAY DRY DOCKS.
Crandall Engineering Co., The, East Boston, Mass.

MARINE RANGES—See RANGES.

MARINE REFRIGERATION—See REFRIGERATING PLANTS.

MARINE SIGNALS—See SIGNALS.

MARINE SUPERHEATERS.
Babcock & Wilcox Co., New York.
Locomotive Superheater Co., New York.

MARINE SUPPLIES.
Ferdinand, L. W., & Co., Boston, Mass.

MASTS, STEEL.
Welin Marine Equipment Co., Long Island City, N. Y.

MECHANICAL DRAFT.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

MEGAPHONES—See CHANDLERY STORES.

METAL WORKING TOOLS—See TOOLS, MACHINE.

METALLIC PACKING—Also see PACKING.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Johns-Manville, H. W., Co., New York.
Lockwood Mfg. Co., East Boston, Mass.
United States Metallic Packing Co., Philadelphia, Pa.

METRES, ELECTRIC.
General Electric Co., Schenectady, N. Y.
Weston Electrical Instrument Co., Waverly Park, Newark, N. J

MILLING MACHINES.
Niles-Bement-Pond Co., New York.

MINERAL WOOL—See NON-CONDUCTING COVERING.

MONITOR NOZZLES—See HOSE NOZZLES.

MOORING ENGINES.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.

MOTOR BOATS—See LAUNCHES AND YACHTS.

MOTOR BOAT SUPPLIES.
Ferdinand, L. W., & Co., Boston, Mass.
Johns-Manville Co., H. W., New York.

MOTORS, ELECTRIC.
General Electric Co., Schenectady, N. Y.

MOTORS, GASOLINE—See GASOLINE ENGINES.

MULTIPLE DRILLS.
Niles-Bement-Pond Co., New York.

NAVAL ARCHITECTS—See PROFESSIONAL CARDS.

NEEDLE VALVES—See VALVES.

NIPPLES.
National Tube Co., Pittsburg, Pa.

NON-CONDUCTING COVERING.
Johns-Manville, H. W., Co., New York.

NOZZLES—See HOSE NOZZLES.

NUTS—See BOLTS AND NUTS.

OAKUM.
Baltimore Oakum Co., Baltimore, Md.
Davey, W. O., & Sons, Jersey City, N. J.
Welin Marine Equipment Co., Long Island City, N. Y.

OIL—See LUBRICANTS.

OIL BURNERS, FUEL—See FUEL OIL BURNERS.

OIL CUPS—See LUBRICATORS.

OIL ENGINES—See ENGINES, OIL.

OIL FUEL APPARATUS.
Schutte & Körting Co., Philadelphia, Pa.

OIL GAUGES.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., The, Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

OIL PUMPS.
Lunkenheimer Co., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

OILING SYSTEMS—Also see LUBRICATORS.
Albany Lubricating Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., Wm., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

ORANGE PEEL BUCKETS—See DREDGING MACHINERY.

ORE DOCKS—See DOCKS.

ORE HANDLING MACHINERY.
Brown Hoisting Machinery Co., Cleveland, Ohio.
McMyler-Interstate Co., The, Cleveland, Ohio.

PACKING—Also see METALLIC PACKING.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Johns-Manville, H. W., Co., New York.
Lockwood Mfg. Co., East Boston, Mass.
Peerless Rubber Mfg. Co., New York.

PACKING, ASBESTOS.
Johns-Manville, H. W., Co., New York.

PAINT—Also see GRAPHITE; also MARINE PAINT.
Dixon, Jos., Crucible Co., Jersey City, N. J.
Johns-Manville Co., H. W., New York.

PATENT ATTORNEYS—See ATTORNEYS, PATENT.

PETROL ENGINES—See GASOLINE ENGINES.

PHOSPHOR BRONZE CASTINGS.
Griscom-Russell Co., New York.
Hyde Windlass Co., Bath, Maine.
Lunkenheimer Co., Cincinnati, Ohio.

PILE DRIVERS.
McMyler-Interstate Co., The, Cleveland, Ohio.

PIPE COVERING—See NON-CONDUCTING COVERING.

PIPE CUTTING AND THREADING MACHINES.
Niles-Bement-Pond Co., New York.

PIPE FLANGES—See FLANGES.

PIPE UNIONS.
Dart, E. M., Mfg. Co., Providence, R. I.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Powell Co., The, Wm., Cincinnati, Ohio.
Williams Valve Co., D. T., Cincinnati, Ohio.

PIPE WRENCHES.
Williams & Co., J. H., Brooklyn, N. Y.

PLANERS, STANDARD METAL WORKING AND ROTARY.
Niles-Bement-Pond Co., New York.

PLANERS, SHIP PLATE.
Niles-Bement-Pond Co., New York.

PLANIMETERS.
Star Brass Mfg. Co., Boston, Mass.

PLATE-BENDING ROLLS.
Niles-Bement-Pond Co., New York.

PLUMBAGO—Also see GRAPHITE.
Dixon, Jos., Crucible Co., Jersey City, N. J.

PLUMBING—Also see CHANDLERY STORES.
Davidson, M. T., Co., New York.
Sands, Alfred B., & Son Co., New York.

PNEUMATIC SEPARATORS.
Griscom-Russell Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

PNEUMATIC TOOLS—Also see AIR COMPRESSORS.
Independent Pneumatic Tool Co., Chicago and New York.

POPPET VALVES—See VALVES.

PORTABLE CYLINDER BORING BARS—See CYLINDER BORING BARS.

PORTABLE DRILLS.
General Electric Co., Schenectady, N. Y.

POWER PUNCHES AND SHEARS—See TOOLS, MACHINE.

PRESSURE REGULATORS.
Ashton Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

PRODUCERS—See MARINE GAS PRODUCERS.

PROFESSIONAL CARDS.
Cox & Stevens, New York.
Decker, Delbert H., Millerton, N. Y.
Donnelly, W. T., New York.
Hough, Edward S., San Francisco, Cal.
Watts, J. Murray, Philadelphia, Pa.

PROJECTORS—See SEARCHLIGHTS.

PROPELLER WHEELS.
Donnelly, W. T., New York.
Gas Engine & Power Co., and Chas. L. Seabury & Co., Consol., Morris Heights, N. Y.
Hyde Windlass Co., Bath, Me.
Sheriffs Mfg. Co., Milwaukee, Wis.
Trout, H. G., Co., Buffalo, N. Y.
Watts, J. Murray, Philadelphia, Pa.

PROPELLING ENGINES—See ENGINES, PROPELLING.

PUMPING MACHINERY—SEE ENGINES, PUMPING.

PUMPS—ALSO SEE ENGINES, PUMPING.
Alberger Pump and Condenser Co., New York.
Davidson, M. T., Co., New York.
De Laval Steam Turbine Co., Trenton, N. J.
Griscom-Russell Co., New York.
Hyde Windlass Co., Bath, Maine.
Kingsford Foundry & Machine Works, Oswego, N. Y.
Sands, A. B., & Son Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Machine Co., East Pittsburgh, Pa.

PUMPS, BILGE—See BILGE PUMPS.

PUMPS, DREDGING.
Terry Steam Turbine Co., Hartford, Conn.

PUMPS, MARINE GLUE.
Ferdinand, L. W., & Co., Boston, Mass.

PUNCHING MACHINES AND SHEARING MACHINES, HYDRAULIC POWER AND HAND.
Niles-Bement-Pond Co., New York.

PYROMETERS.
Taylor Instrument Companies, Rochester, N. Y.

QUADRANT DAVITS—See DAVITS.

RAFTS—See LIFE BOATS AND RAFTS.

RAILWAY DRY DOCKS.
Crandall Engineering Co., East Boston, Mass.

RANGE FINDERS.
Nicholson Ship Log Co., Cleveland, Ohio.

RANGES.
Sands, A. B., & Son Co., New York.

RASPS.
Nicholson File Co., Providence, R. I.

REAMERS.
Morse Twist Drill & Machine Co., New Bedford, Mass.

REAMERS—PNEUMATIC.
Independent Pneumatic Tool Co., Chicago and New York.

RECORDING COMPASSES.
Nicholson Ship Log Co., Cleveland, Ohio.

REDUCING VALVES—See VALVES.

REFLEX WATER GAUGES.
Jerguson Gage & Valve Co., Boston, Mass.

REFRIGERATING ENGINEERS—See ENGINEERS, CONSULTING.

REFRIGERATING MACHINERY.
Brunswick Refrigerating Co., New Brunswick, N. J.
Johns-Manville Co., H. W., New York.
Kroeschell Bros. Ice Machine Co., Chicago, Ill.
Roelker, H. B., New York.

REGRINDING VALVES—See VALVES.

RELEASING GEAR.
Welin Marine Equipment Co., Long Island City, N. Y.

RELIEF VALVES—See VALVES.

RESEATING MACHINES—See VALVE RESEATING MACHINES.

REVOLUTION COUNTERS.
Ashton Valve Co., Boston, Mass.
McNab Co., The, Bridgeport, Conn.

RHEOSTATS.
General Electric Co., Schenectady, N. Y.
Simplex Electric Heating Co., Cambridge, Mass.

RIGGING—See WIRE ROPE.

RIVER BOATS—Also see SHIPBUILDERS AND DRY DOCK COS.
Gas Engine & Power Co., and Chas. L. Seabury & Co., Consol., Morris Heights, N. Y.
Marine Iron Works, Chicago, Ill.
Merrill-Stevens Co., Jacksonville, Fla.
Ward, Chas., Engineering Works, Charleston, W. Va.

RIVETING MACHINES, HYDRAULIC AND STEAM POWER.
Independent Pneumatic Tool Co., Chicago and New York.
Niles-Bement-Pond Co., New York.

RIVETERS, PNEUMATIC.
Independent Pneumatic Tool Co., Chicago and New York.

ROLLER BEARINGS—See THRUST BEARINGS.

ROLLS, BENDING AND STRAIGHTENING.
Niles-Bement-Pond Co., New York.

ROOFING PAINTS.
Ferdinand, L. W., & Co., Boston, Mass.
Johns-Manville Co., H. W., New York.

ROPE—Also see WIRE ROPE, TRANSMISSION ROPE, and MANILA AND SISAL ROPE.
Columbian Rope Co., Auburn and New York.
Durable Wire Rope Co., Boston, Mass.
Griscom-Russell Co., New York.
Phosphor-Bronze Smelting Co., Ltd., Philadelphia, Pa.
Waterbury Co., New York.
Whitlock Cordage Co., New York.

ROTARY BLOWERS—See BLOWERS.

ROWBOATS—See LAUNCHES AND YACHTS.

RUBBER BELTING.
Johns-Manville Co., H. W., New York.
New York Belting & Packing Co., New York.

RUBBER GOODS—Also see Packing—Also see INTERLOCKING RUBBER TILING.
Griscom-Russell Co., New York.
Johns-Manville Co., H. W., New York.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.

RUBBER MATTING CEMENT.
Ferdinand, L. W., & Co., Boston, Mass.

RUBBER TILING—See INTERLOCKING RUBBER TILING.

RUBBER VALVES—See VALVES, RUBBER.

SAFETY DEVICES—See LIFE SAVING DEVICES.

SAFETY VALVES—See VALVES.

SANITARY FITTINGS—See PLUMBING.

SANITARY PUMPS—See PLUMBING.

SEARCHLIGHTS.
General Electric Co., Schenectady, N. Y.

SENTINEL VALVES—See VALVES.

SEPARATORS—PNEUMATIC—See PNEUMATIC SEPARATORS

SHAFTING—HOLLOW, SEAMLESS STEEL.
National Tube Co., Pittsburg, Pa.

SHAFT STEEL—See STEEL SHAFTING.

SHALLOW-DRAFT RIVER BOATS—See RIVER BOATS. Also SHIPBUILDERS AND DRY DOCK COMPANIES.

SHEARING MACHINES, HYDRAULIC, STEAM POWER AND HAND.
Niles-Bement-Pond Co., New York.

SHEATHING METAL—See YELLOW METAL; also BRASS AND COPPER.

SHEATHING, ASBESTOS.
Johns-Manville, H. W., Co., New York.

SHIPBUILDERS AND DRY DOCK COMPANIES—See also RIVER BOATS.
Bath Iron Works, Bath, Maine.
Fletcher, W. & A., Co., Hoboken, N. J.
Fore River Shipbuilding Corporation, Quincy, Mass.
Gas Engine & Power Co., and Chas. L. Seabury & Co., Consol., Morris Heights, N. Y.
Krajewski-Pesant Corporation, Havana, Cuba.
Marine Iron Works, Chicago, Ill.
Marvel, T. S., Shipbuilding Co., Newburg, N. Y.
Merrill-Stevens Co., Jacksonville, Fla.
Newport News Shipbuilding & Dry Dock Co., Newport News, Va.
Seattle Construction & Dry Dock Co., Seattle, Wash.
Tietjen & Lang Dry Dock Co., Hoboken, N. J.
Ward, Chas., Engineering Works, Charleston, W. Va.

SHIP CHANDLERS—See CHANDLERY STORES.

SHIP ELEVATORS—See MARINE ELEVATORS.

SHIP FITTINGS.
Ferdinand, L. W., & Co., Boston, Mass.
Griscom-Russell Co., New York.

SHIP GLUE—See MARINE GLUE.

SHIP LOGS AND SPEED INDICATORS.
Nicholson Ship Log Co., Cleveland, Ohio.
Schuette Recording Compass Co., Manitowoc, Wis.

SHIP STORES—See CHANDLERY STORES.

SHIPYARDS—See SHIPBUILDERS.

SHOWER BATHS—See PLUMBING.

SLOTTING MACHINES.
Niles-Bement-Pond Co., New York.

SMOOTH-ON.
Smooth-On Mfg. Co., Jersey City, N. J.

SPEED INDICATORS FOR SHIPS, YACHTS AND MOTOR BOATS.
Johns-Manville Co., H. W., New York.

STEAM ENGINE INDICATORS—See INDICATORS.

STEAM ENGINES—See ENGINES.

STEAM GAUGES.
Ashton Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

STEAM HAMMERS.
Niles-Bement-Pond Co., New York.

STEAM AND HOT-BLAST APPARATUS.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

STEAM PUMPS—See PUMPS.

STEAM SEPARATORS.
Griscom-Russell Co., New York.
Williams Valve Co., D. T., Cincinnati, Ohio.

STEAM SHOVELS—See DREDGING MACHINERY.

STEAM SPECIALTIES.
Alberger Pump and Condenser Co., New York.
American Blower Co., Detroit, Mich.
Ashton Valve Co., Boston, Mass.
Griscom-Russell Co., New York.

Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Powell, Wm., Co., New York.
Schutte & Körting Co., Philadelphia, Pa.
Star Brass Mfg. Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

STEAM SUPERHEATERS—See MARINE SUPERHEATERS.

STEAM TRAPS.
American Blower Co., Detroit, Mich.
Griscom-Russell Co., New York.
National Tube Co., Pittsburg, Pa.
Schutte & Körting Co., Philadelphia, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Williams Valve Co., D. T., Cincinatti, Ohio.

STEAM TURBINES.
Alberger Pump and Condenser Co., New York.
Bath Iron Works, Bath, Maine.
De Laval Steam Turbine Co., Trenton, N. J.
Fletcher, W. & A., Co., Hoboken, N. J.
Fore River Shipbuilding Corporation, Quincy, Mass.
General Electric Co., Schenectady, N. Y.
Parsons Marine Steam Turbine Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford, Conn.
Westinghouse Machine Co., East Pittsburgh, Pa.

STEAM TURBINE DYNAMOS.
De Laval Steam Turbine Co., Trenton, N. J.
General Electric Co., Schenectady, N. Y.
Westinghouse Machine Co., East Pittsburgh, Pa.

STEAMERS, LIGHT-DRAFT, RIVER—See RIVER BOATS.

STEEL BALLS.
Bantam Anti-Friction Co., Bantam, Conn.

STEEL PIPE.
Continental Iron Works, The, Brooklyn, N. Y.
National Tube Co., Pittsburgh, Pa.

STEEL VALVES—See FORGED STEEL VALVES.

STEERING GEARS.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.

STEERING ENGINES.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.
Lidgerwood Mfg. Co., New York.
Sheriffs Mfg. Co., Milwaukee, Wis.

STEERING WHEELS.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.

STOP COCKS—See VALVES.

STOVES—See RANGES.

STRAIGHTENING ROLLS—See ROLLS.

SUBMARINE ARMOR.
Schrader's Son, A., Inc., Brooklyn, N. Y.

SUPERHEATERS—See MARINE SUPERHEATERS.

SUPERHEATER TUBES.
National Tube Co., Pittsburg, Pa.

SURFACE CONDENSERS—See CONDENSERS.

SWITCHBOARDS—See ELECTRICAL INSTRUMENTS.

TACKLE BLOCKS—See BLOCKS.

TANKS—COPPER, GALVANIZED IRON.
Griscom-Russell Co., New York.
Sands, A. B., & Son Co., New York.

TANKS, SEAMLESS STEEL.
Continental Iron Works, The, Brooklyn, N. Y.
National Tube Co., Pittsburgh, Pa.

TANKS, WELDED STEEL.
Continental Iron Works, The, Brooklyn, N. Y.

TEAK—See LUMBER.

THERMOMETERS—FOR EVERY PURPOSE.
H. & M. Division of the Taylor Instrument Cos., Rochester, N. Y.

THERMIT WELDING.
Goldschmidt Thermit Co., New York.

THREADING AND CUTTING MACHINES—See PIPE CUTTING AND THREADING MACHINES.

THROTTLE VALVES—See VALVES.

THRUST BEARINGS.
Bantam Anti-Friction Co., Bantam, Conn.

TILING—See INTERLOCKING RUBBER TILING.

TOILET ACCESSORIES.
Johns-Manville Co., H. W., New York.
Sands, A. B., & Son Co., New York.

TOOLS, MACHINE.
Niles-Bement-Pond Co., New York.

TOOLS, MACHINISTS' AND CARPENTERS—See BENCH TOOLS

TOWING HOOKS AND CHOCKS.
American Engineering Co., Philadelphia, Pa.

TOWING MACHINES.
American Engineering Co., Philadelphia, Pa.

TRANSMISSION ROPE—See ROPE.

TRAPS—See STEAM TRAPS.

TUBES—See BOILER TUBES; also BRASS AND COPPER.

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TUBE CUTTERS—See BOILER TUBE CUTTERS.

TUGS—See SHIPBUILDERS.

TURBINES—See STEAM TURBINES.

TURNING ENGINES.
American Engineering Co., Philadelphia, Pa.

TURRET LATHES—See LATHES, TURRET.

TWINE—See ROPE—Also CORDAGE.
Columbian Rope Co., Auburn, N. Y.
Waterbury Co., New York.
Whitlock Cordage Co., New York.

TWIST DRILLS.
Morse Twist Drill & Machine Co., New Bedford, Mass.

UNIONS—See PIPE UNIONS.

VACUUM GAUGES—See STEAM GAUGES.

VACUUM TRAPS.
Griscom-Russell Co., New York.
Williams Valve Co., D. T., Cincinnati, Ohio.

VALVE RESEATING MACHINES.
Leavitt Machine Co., Orange, Mass.

VALVES—Also see RUBBER VALVES AND WATER VALVES.
Ashton Valve Co., Boston, Mass.
Griscom-Russell Co., New York.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Powell, Wm., Co., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.
Star Brass Mfg. Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

VALVES — BALANCED THROTTLE VALVES AND QUADRANT VALVES FOR SHIP ENGINES.
Schutte & Körting Co., Philadelphia, Pa.

VALVES, WATER.
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Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburgh, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

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VENTILATORS.
Sands, A. B., & Son Co., New York.

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WATER COLUMNS.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Star Brass Mfg. Co., Boston, Mass.

WATER GAUGES AND ALARMS.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

WATERPROOF CANVAS—See CANVAS, WATERPROOF.

WATERPROOF LIQUID CEMENT.
Ferdinand, L. W., & Co., Boston, Mass.

WATERPROOF LIQUID GLUE.
Ferdinand, L. W., & Co., Boston, Mass.

WATERPROOF PAINT.
Dixon, Joseph, Crucible Co., Jersey City, N. J.
Ferdinand, L. W., & Co., Boston, Mass.

WATERTUBE BOILERS—See BOILERS.

WATER VALVES—See VALVES, WATER.

WELDING AND WELDING APPARATUS.
Goldschmidt Thermit Co., New York.

WHARF DROPS.
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WHISTLES.
Ashton Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., The Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

WHITE METAL
Griscom-Russell Co., New York.

WINDLASSES.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Me.
Lidgerwood Mfg. Co., New York.

WINCHES—See WINDLASSES.

WIRE ROPE
American Engineering Co., Philadelphia, Pa.
Durable Wire Rope Co., Boston, Mass.
Waterbury Co., New York.

WOOD SAWS—PNEUMATIC.
Independent Pneumatic Tool Co., Chicago and New York.

WRENCHES—Also see PIPE WRENCHES.
Williams & Co., J. H., Brooklyn, N. Y.

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YACHTS—See LAUNCHES AND YACHTS; also SHIPBUILDERS.

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PALMETTO

DECEMBER, 1915

INTERNATIONAL MARINE ENGINEERING

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DECEMBER, 1915

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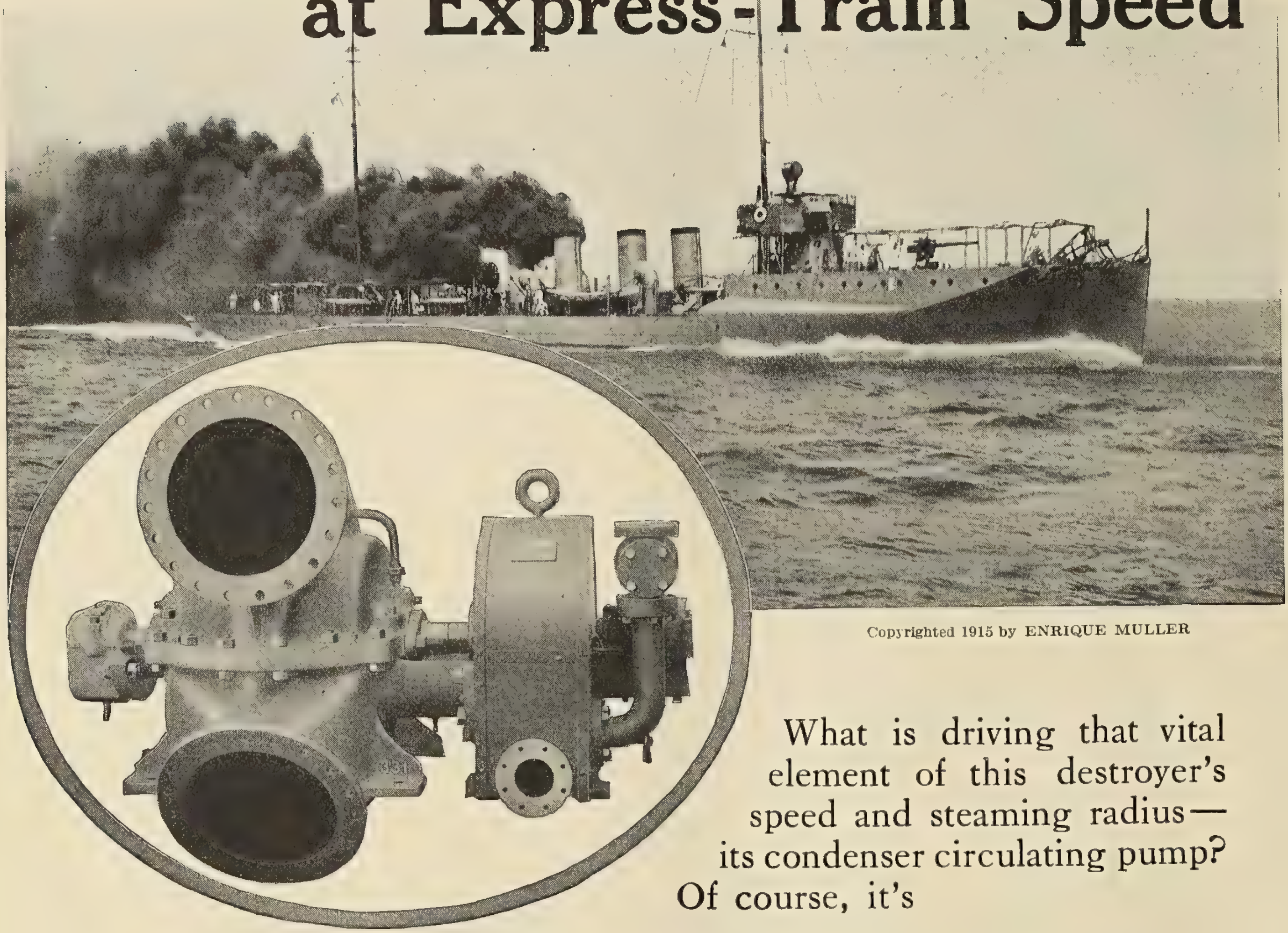
WHITEHALL BUILDING
17 BATTERY PLACE

Notice to Advertisers.—Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 20th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 15th of the month.

INTERNATIONAL MARINE ENGINEERING *is member No.* 448 *of the Audit Bureau of Circulations.*

3,800 copies of this issue were printed.

Tearing Through the Sea at Express-Train Speed



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What is driving that vital element of this destroyer's speed and steaming radius—its condenser circulating pump? Of course, it's

THE TERRY TURBINE

The photo shows one of the two Terry Turbine Pumping Sets each of 4800 gallons per minute capacity furnished the Bath Iron Works, Limited, for the U. S. Destroyer WADSWORTH, and is the latest type of many built for condenser circulating service.

Henry R. Worthington furnished the pump for this set, as well as for many others.

Terry Turbine sets are now being used aboard war ships and merchant vessels for not only condenser circulating service, but main dynamo condenser circulating, distiller circulating and main boiler feed pumps. In fact they are used just as on land for duty where continuous service is absolutely essential.

Write for Bulletin 163.

The Terry Steam Turbine Company

Hartford **Connecticut**

Atlanta, Boston, Birmingham, Charlotte, Chicago, Cleveland, Dallas, Dayton, Denver, Grand Rapids, Houston, Lynchburg, Memphis, New York, New Orleans, Philadelphia, Pittsburgh, San Antonio, San Francisco, St. Louis, Seattle, St. Paul, Montreal, Toronto

Havana, Cuba — London, England — Johannesburg, So. Africa — Melbourne, Australia

T310

TRADE PUBLICATIONS

"Apexior" is described by Phillip Bellows, 74 Pearl street, Boston, Mass., in a circular just issued. "Apexior" is described as being "not a boiler fluid but a compound to be applied to the inside surface of boilers, steam turbines, feed heaters, evaporators, etc., to prevent the forming and adhesion of scale, corrosion and pitting."

The Blake-Knowles twinplex beam air pump for use on shipboard, is described in a circular published by the Marine Department of the Blake & Knowles Steam Pump Works, 115 Broadway, New York. This apparatus is a system of wet and dry vacuum pumps combined to form a unit of minimum weight, occupying the least possible space and capable of great efficiency in service. One cylinder takes the condensed steam and the other cylinder the air and uncondensed vapors, the whole being handled in such a manner that the dry cylinder displacement requirement is less, and the efficiency of the unit higher than in the case of an ordinary air pump.

Searchlight projectors are described by Engberg's Electric & Mechanical Works, 6 Vine street, St. Joseph, Mich., in a circular the company has just published. "Engberg searchlight projectors can be furnished from 8 to 20 inches in diameter. They are especially adapted for ocean, lake and river navigation. When used in connection with an Engberg direct-connected generating set, they make an ideal installation for vessels of any size. Remember, both generating sets and searchlights have been adopted by the leading shipbuilding concerns and very extensively by the United States and Canadian Governments."

The main steering gear for the United States battleship *Pennsylvania,* which the Newport News Shipbuilding & Dry Dock Company is building, was furnished by the Kerr Turbine Company, Wellsville, N. Y., and is described in a corcular the company has just issued. The gear illustrated in this circular has 104 teeth, is 9 inches wide and has a pitch diameter of approximately 7 feet. Those familiar with the stringent Government specifications in such cases can realize the magnitude of the contract which the Kerr Turbine Company undertook in agreeing to furnish a gear of this size according to specifications.

Thermometers for every service are manufactured by the H. & M. Division of the Taylor Instrument Companies, Rochester, N. Y., and are described in a profusely illustrated catalogue the company has just issued. In addition, the Taylor Instrument Companies make straight and angle stem temperature and pressure regulators, mercury vacuum and absolute pressure gages, glass stem engraved thermometers, hygrometers and hydrometers, and thermo-electric and radiation pyrometers.

Bulletin No. 50—The Phenix Force Feed Lubricator—recently issued by The Richardson-Phenix Company, Milwaukee, Wis., contains a complete description of the Phenix ratchet type lubricator; it also describes a new type, known as the Model "T." The catalogue contains an interesting diagram, giving a comparison of the way in which mechanical and hydrostatic lubricators feed oil to engine cylinders. Numerous illustrations show the application of the Phenix lubricator to different types of engines, pumps, steam hammers, etc.

A complete line of steamship berths, also brass and iron beds, mattresses and pillows, is made by the Bernstein Manufacturing Company, Department C, Third and Allegheny avenue, Philadelphia, Pa., and is described in Catalogue 17 just published. The catalogue states that the company makes a complete, practical and efficient line—"a berth to successfully meet every condition on board ship." One of the distinctive features of the Bernstein No. 5550 folding berth is that it cannot work out of the supporting socket. Bernstein berths have been supplied for leading shipbuilders throughout the United States and other countries.

Ozonators for cold storage warehouses are described by the Sprague Electric Works, 527 West Thirty-fourth street, New York, in a bulletin just published. "Although reliable and satisfactory ozonators have been on the market but a few years, they have already become a recognized adjunct to the equipment of all modern up-to-date cold storage houses. Ozone is simply the oxygen of the air changed into a highly active state by the action of the electric current in the Ozonator. In this form it has the remarkable power of destroying by oxidation or burning up the odor-bearing particles of matter floating in the air. This results in the permanent removal of the odor without the necessity of introducing chemicals of any kind."

Valves of all kinds for marine use are described in a catalogue published by the Pratt & Cady Company, Inc., Hartford, Conn.

All-manila rope is described in a catalogue published by the Whitlock Cordage Company, Department M, 46 South street, New York. The Whitlock manila is guaranteed to be all-manila, and to give maximum service.

Prosser boiler tube expanders are the subject of a circular published by Thomas Prosser & Son, 24 Platt street, New York. This company makes boiler tube expanders of its own standard, or will make them to any special shape and size desired.

Lap welded pipe, flues, drums, cylinders, boiler flanges, Taylor seamless boiler nozzles and corrugated furnaces are described by the American Spiral Pipe Works, P. O. Box 485, Chicago, Ill., in a bulletin the company has just issued.

The Lennox serpentine shear is the subject of Bulletin No. 50, published by Joseph T. Ryerson & Son, Chicago, Ill. In the bulletin are illustrated fourteen shapes cut with a Lennox shear, which is stated to be economical and rapid in this work. Anyone interested in this subject should send for a copy of the bulletin.

Waterbury rope—wire rope, armored wire rope and fiber-clad wire rope—is described in a catalogue just published by Waterbury Company, 63 Park Row, New York. In this catalogue the statement is made that the Waterbury Company is the only manufacturer making every kind of rope used aboard a vessel, and it can supply every rope need from stem to stern.

"Some Users of D-B Apparatus" is the title of a booklet published by the Davis-Bournonville Company, Jersey City, N. J. A copy of this booklet will be sent to anyone on request, together with a catalogue showing the wide range of oxy-acetylene apparatus made by the Davis-Bournonville Company for both stationary and portable use. The company will also send bulletins on any kind of work in which you are interested, either welding or cutting.

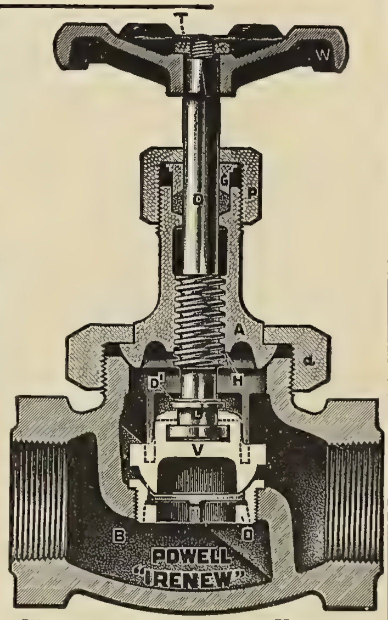
Tools and instruments of precision are described in Catalogue 20-L, issued by the L. S. Starrett Company, Athol, Mass. Whether you are a machinist, a foreman, a superintendent, an engineer or manufacturer, the Starrett Company has tools for your use which are designed to save time. For example, the Starrett quick-acting micrometer can be instantly opened or closed to any point ready for the fine adjustment.

"The Oster Pipe Threading Machine" is the subject of a catalogue issued by the Oster Manufacturing Company, 2117 East Sixty-first street, Cleveland, Ohio. This machine is stated to require less floor space than the ordinary pipe threading machine, and yet to thread bent pipe, bolts and nipples as well as straight pipe. It is belt or motor-operated, threads bolts from ½ to 1⅝ inches, and pipe from 1 to 4-inch sizes.

A valveless oil engine, which is guaranteed to produce full power from stone-cold in 10 seconds, is described and fully illustrated in Catalogue 3 I-M, just issued by the Southwark Foundry Machine Company, 430 Washington avenue, Philadelphia, Pa. In this catalogue the statement is made that a 150-horsepower engine installed in a yacht has been in daily operation for several months, and recently made a trip from Philadelphia to New York in 24 hours against a stiff north-east wind and sea, consuming but 169 gallons of Mexican fuel oil at 2½ cents per gallon.

"Why Burn Up Profits?" is the title of a circular published by The Improved Combustion Company, People's Gas building, Chicago, Ill. In this circular the company gives a photograph of a check for $1,548.30 received from a steamboat company, which it states was for a 60 percent saving in cost of fuel for one month on four Mississippi River steamers, the actual saving being $2,580. "The cost of our installation will be paid for in a few months, and then the owners of the line will have this great additional profit in operation with no discount of any kind."

The Cummings Direction Indicator is the subject of an illustrated catalogue published by the Cummings Ship Instrument Works, 110 High street, Boston, Mass. This instrument has one pipe and no valves, and is operated by means of pressure or vacuum produced by a small pump connected to the propeller shaft. For rotation forward the vanes within the pump produce a partial vacuum, throwing the pointer into the ahead position. When the shaft is reversed the vanes of the pump produce a definite pressure within the pipe leading to the indicator, thus throwing the pointer into the astern position. As soon as the shaft comes to rest the indicator returns to zero.



Mietz & Weiss oil engines for marine service are described in Bulletin M-21, which the August Mietz Works, 130 Mott street, New York, has just issued. These oil engines have no carburetor and no electric ignition.

"Centrifugal Pumps" is the title of a 64-page bulletin just issued by The Terry Steam Pump Company, Hartford, Conn., giving details and data on various turbo-pump applications. The principles of operation and construction of the centrifugal pump are clearly explained, as are the details of the steam turbines which have been successfully used during the past ten years for driving them. Because of the wide latitude of speed possible with the turbine, the unit occupies a much smaller space than would be required for a pump performing the same duty but driven by a reciprocating engine. The range of conditions in this service varies from large volumes of water pumped against low heads, such as circulating water for condensers or for irrigation up to high head work, such as boiler feeding or fire service. The reliability and entire freedom from shut down due to accidents, repairs or packing renewals, have placed the Terry pumping units in a class by themselves. This booklet should certainly be in the hands of those who are interested in any kind of a pumping problem.

Ships' winches are described by the Lidgerwood Manufacturing Company, 96 Liberty street, New York, in a catalogue the company has just published. These machines are stated to be built upon a duplicate part system, insuring an absolute fit and prompt delivery of spare parts. The winches handle cargo rapidly, economically and quickly, thus saving ships' time in port.

Firetube superheaters for marine boilers are described in Catalogue "A," published by the Locomotive Superheater Company, 30 Church street, New York. The Schmidt superheater, which is described in this catalogue, is stated to save from 10 to 25 percent of fuel per unit of power developed, and to increase the power output of a given marine power plant from 10 to 25 percent. It is adaptable to either new or existing boilers of the firetube type, with no change in their design or construction.

High-speed twist drills. reamers, countersinks, flue cutters and lathe tools are described in illustrated Catalogue No. 15, just published by the Celfor Tool Company, Buchanan, Mich. "The Celfor Tool Company is the pioneer in the manufacture of high-speed twisted drills. We originated and perfected the twist drill, and our efforts have since been devoted to the manufacture of drills and other tools by the twisting process. Since the first twisted high-speed drill was placed on the market by this company, it has been conclusively proven that tools so made possess distinct advantages over those milled from the solid. The forging or rolling of our sections to shape before twisting, tends to densify the metal and produces tools which cannot be excelled for strength and cutting qualities. We were the first to recognize that high-speed drills must have ample chip clearance and extra large shanks to accomplish the work for which they are intended. Our success in producing thoroughly efficient tools is attested by our large and constantly growing business."

Duplex block metallic packing is described in a circular which has just been issued by the United States Metallic Packing Company, 429 North Thirteenth street, Philadelphia, Pa. "This packing is in two independent sections, separated by the dividing piece, the upper section, consisting of white metal rings with vibrating cup, follower, etc., being in the stuffing-box, and the lower section, consisting of blocks with horn rings, sliding plate, ball joint, etc., being contained in the gland. The upper or inner set of packings consists of three babbitt metal rings, each in three parts, contained in the vibrating cup. There is a ground joint between the flat face of the vibrating cup and the dividing piece. Above the babbitt metal rings come the follower and the upper spring bushing in pockets, in which are contained the upper follower springs, and then in the bottom of the stuffing-box the preventer, varying in length according to the depth of the box. As the dividing piece is bolted to the face of the stuffing-box independently of the gland which contains the lower or outer set of packing, the blocks in the lower set may be renewed or any other necessary work done to same without taking down the upper set of packing or in any way disturbing it. The lower or outer section of the packing consists of eight blocks, babbitt lined, which are held in rings having horns holding springs. The packing blocks are put together in sections, four blocks to a section. Each section is composed of two working blocks and two guide blocks. The joints between the blocks in each section are at right angles to each other, thus breaking joint. Small follower springs in pockets are also used behind the follower plate. The combination of the sliding plates and ball ring having ground surfaces allows for the movement of rods out of line. The spring pressure is so regulated as to merely hold the parts in place when the engine is running without steam. A hole is drilled in the gland for a nipple and globe valves so that condensation can be drained off."

"Oleite," for freeing feed water from every particle of oil, is described in Catalogue D-10, published by William Andrews, Inc., 120 Liberty street, New York. The use of "Oleite" is especially recommended on board ship.

"Durable" wire rope for mooring, towing hawsers, ships' rigging, and all similar purposes, is described in a catalogue just issued by the Durable Wire Rope Company, 93 Pearl street, Boston, Mass. The manufacturer states that this rope is made of selected steel, and that each strand is separately served with especially prepared hemp marlin. The rope is also stated to combine the pliability and wearing service of hemp or manilla ropes with the strength of ordinary wire rope, avoiding the disadvantages of both, and being more durable and economical than either.

A full line of valves is described in a circular issued by McNab & Harlan Manufacturing Company, 55 John street, New York. "To meet the demands of the trade and marine engineers for a first-class valve, we have designed and made equipment to produce a full line of regrinding valves. These valves are manufactured under strictly up-to-date methods. Compared with other valves of this type, the workmanship and alinement of all parts are second to none. The metal is of the very best quality steam metal, and selected after careful consideration and chemical and physical tests to be the most satisfactory to give service where conditions require a valve of superior quality."

Regrinding valves are described in an illustrated pamphlet just published by the Penberthy Injector Company, Detroit, Mich. "The ever-increasing demand to-day by power plant owners and steam users in general is for valves that will give absolutely reliable service and dependability under high pressures and severe conditions, and that are free from unnecessary renewal of disks and repair parts. To meet this demand the Penberthy regrinding valve has been designed. It is the result of many years of practical experience in the manufacture of high-grade brass goods, and embodies the best mechanical ideas ever employed in mechanical valve construction. The distribution of metal is such that parts subjected to the greatest strain and wear have proportionately heavier walls. For the present we illustrate only the medium pattern type, which is designed to stand a constant working pressure of 200 pounds."

Revolution counters for marine use are among the instruments described by the Veeder Manufacturing Company, Hartford, Conn., in a catalogue just published.

J-M Sea Rings. according to an illustrated "Blue Book (a copy of which will be sent free to any of our readers upon request), eliminate 75 percent of the waste of power caused by rod friction. This blue book is published by the H. W. Johns-Manville Company, Forty-first street and Madison avenue, New York, and a copy should be in the hands of all engineers and shipowners. In this book the statement is made that it is estimated that rod friction, caused by soft packing, consumes at least 5 percent of engine power. J-M sea rings are self-lubricating, and it is stated that they will withstand the highest temperatures and pressures; that they are ideal for superheated steam, high-pressure hydraulics, marine engines, hot and cold water pumps, etc.

The Never-Slip Safety Clamp for handling boiler plate is described in a circular just published by the Never-Slip Safety Clamp Company, 141 Broadway, New York. "The Never-Slip Safety Clamp is superior to any other clamp ever put on the market, combining great strength with absolute safety and considerable saving in time and labor. The clamps are made of high-class open-hearth steel and are annealed. They cannot slip, but give a strong, tight grip and are very easily attached or removed. Size No. 1 will lift plates up to ¾ inch thick, and has a capacity of 6 tons per pair, or being able to lift 400 square feet of plate with absolute safety; weight per pair 10 pounds. Size No. 2 will lift plates from ¾ inch to 1½ inches thick, and has a capacity of 9 tons per pair, thus being able to lift 300 square feet of plate with absolute safety; weight per pair 30 pounds. Size No. 3 lifts plates from 1½ inches to 2 inches, and has a capacity of 12 tons per pair, thus lifting 300 square feet with absolute safety; weight per pair 72 pounds. The vertical plate clamps are made also of high-class open-hearth steel and are annealed. Size No. 1 vertical clamp will lift plates up to 1 inch thick, and has a capacity of 4 tons; weight per pair 44 pounds. Size No. 2 vertical clamp will lift plates from 1 inch to 2 inches thick, and has a capacity of 9 tons; weight per pair 84 pounds. Invaluable to boiler makers, rolling mills, foundries, tank constructors, ship yards, or any plant where plates or metal sheets are handled. Cannot slip and by its use costly accidents are avaided."

"Actual Pipe Threading Experiences" is the title of a booklet which has just been published by the Oster Manufacturing Company, 2117 East Sixty-first street, Cleveland, Ohio. In this catalogue is illustrated a combination pipe, bolt and nipple-threading machine for use in ship yards. It is stated that the use of this machine three days a week pays 35 percent on the investment over ordinary pipe threading methods, making it a profitable outlay for both large and small yards. It is furnished in four sizes for either belt or motive drive. For use on board ship the Oster No. 206 geared machine is a strictly one-man tool, making it possible for one man to thread all sizes of pipe from 1 to 6 inches without special effort. The wide range, the two speeds on one crank, and the automatic cutting-off attachment are all features which, it is stated, make it particularly fast and convenient for marine use.

Two Useful Tools.—W. D. Forbes, 230 Hempstead street, New London, Conn., has put on the market a center punch and has published an illustrated circular describing it. Both ends of this punch are hardened, and the knurling is nice and sharp and the workmanship and material of the best. The price, prepaid to any part of the United States, is only 10 cents. Another tool described by Mr. Forbes in the same circular is a surface gage, of which the following statement is made: "A quick, vertical adjustment is obtained by sliding the arm up and down the column and securing it in any desired position by tightening a knurled thumb screw, the thrust of which is taken on a copper washer, which prevents the column from being bruised. A coarse, quick, vertical adjustment of the needle is obtained by loosening a knurled thumb nut, which permits the beam to be tilted on the arm, the thumb-nut holding it securely in position. The out-reach of the needle, which is 1/8 diameter, can be adjusted by sliding it in and out by loosening the knurled thumb-nut shown under the left-hand end of the beam. A micrometer adjustment of the needle is obtained by turning a knurled nut shown in the jaws of the beam at its right-hand end. The base is drilled with two 1/8-inch holes, in which plugs can be placed when the gage is used to set work parallel to the edge of a planer bed or other machine, or where it is more convenient to use the gage on the rail of a planer than from the face of its platen. Price, net, to any part of the United States, $1.25."

Vertical twin beam air pumps are described by M. T. Davidson Company, 154 Nassau street, New York, in a catalogue just issued. The Davidson Company manufactures a full line of marine pumps, condensers, ash ejectors, etc.

The American "Ideal" steam trap is described in an illustrated "Trap Data Booklet," published by the American Steam Gauge & Valve Manufacturing Company, Boston, Mass. In this booklet it is stated that the ideal way to specify steam traps is to know the size orifice in the trap valve. This is what governs the capacity, because no more condensation can pass through the trap than can pass through the valve. This information is published in the booklet mentioned.

"The Motsinger Double Rotary Engine" is the subject of a bulletin published by the Motsinger Rotary Engine Company, Fredonia, Pa. This engine is described in part as follows: "This double rotary engine is so called because it has two rotors, each with two vanes or pistons parallel on each side of an abutment rotor, having two clearance grooves, in such a way that one vane of one engine on one side the abutment rotor receives its steam simultaneously with one vane of the other engine on the other side of the abutment rotor, using a pair of diagonal ports for inlet and a pair of reversed diagonal ports for exhaust—practically forming two powerful co-acting engines exactly alike. We do not believe this principle will ever be surpassed for power production from steam. It is clearly and fundamentally applicable not only for steam and air engines, but for air compressors, vacuum pumps and high-pressure water pumps. Roughly, the general plan consists of a central cylinder or casing having a small bore for the long valve rod above, and three bores below with equal centers in the same horizontal plane to contain the smoothly cut cast iron rotors which are mounted on steel shafts. The two outside rotors have each two vanes or pistons and the middle or abutment rotor has two grooves. Bolted to the cylinder is a steam inlet head on one end and an exhaust head at the other, each containing steam chambers and valves and having adjustable bearings for the two outside rotors. Mounted on extensions of these shafts are three equal gears in an oil-tight case, and a pulley or power wheel is keyed on extension of the center shaft from which power is taken."

"Lowell Duck," which is described as the "standard yacht sail cloth," is the subject of a catalogue which has been published by the Boston Yarn Company, Boston, Mass.

Electric tractors. for use on piers and docks, are described by the Elwell-Parker Electric Company, Cleveland, Ohio, in bulletins recently issued. The company will be very glad to give full information in reference to any particular problem.

"Pneumatic Flanging Machines" is the title of an illustrated catalogue of 18 pages just published by the McCabe Manufacturing Company, Lawrence, Mass. In this catalogue the company presents photographic illustrations of work actually flanged by the McCabe machine in different shops, together with references from many large and successful plate working establishments, with which to prove the company's claims. Among the illustrations of work actually performed are some heads for rectangular tanks, both with round corners and square corners; a round storage tank 10 feet in diameter, ½ inch thick, the head of which has been flanged with the McCabe pneumatic flanging machine; a special tank, showing irregular flanges, made with the same machine; some dished heads, ½ inch in thickness, which were flanged cold; a cone bottom for a rendering tank, and others. The company states that with this method of flanging it is possible to flange plates any length or width and up to ½ inch in thickness cold. This class of flanging is stated to be especially valuable in smoke flues, rectangular up-takes, fireboxes for portable boilers, bulkheads, partitions and deck plates for ship work, etc. The catalogue states that round corners up to 8 inches radius and all thicknesses up to ½ inch are flanged in one heat and with one turn of the bender, and that this operation may be performed on rectangular plates that have been flanged on two or more sides previous to the corner. The company says that although the combination of a hand forge and this pneumatic flanging machine is effective for this work, its special oil heater will give more speed. Among the testimonial reports are some from the Standard Oil Company, the Hodge Boiler Works, East Boston, Mass.; the Christopher Cunningham Company, Brooklyn, N. Y.; the Quaker City Iron Works, Philadelphia; the New England Iron Works, Boston, Mass.; the Scannell Boiler Works, Lowell, Mass.; Michael Fogarty, Inc., New York; the Struthers-Wells Company, Warren, Pa., and others.

Nosing and bending steel shells are described in Bulletin No. 5003 just published by the Hydraulic Press Manufacturing Company, Mt. Gilead, Ohio.

A Drill Bulletin has just been published by the Keller Pneumatic Tool Company, Fond du Lac, Wis. Keller rotary pneumatic drils are described in this bulletin as follows: "Keller rotary type drills are well known as being powerful and durable. All delicate parts are eliminated in this style of portable pneumatic drill. The number of parts is very small as compared with piston drills, and the parts are less liable to wear out or get out of order, making reduced repair cost. The motor runs at a high speed; this means an economical gear reduction and a light-weight machine. There is absolutely no vibration when these tools are in operation, and they are, therefore, especially well adapted for reaming and tapping, besides being a steady tool for drilling and flue expanding. The material used in the drills is of the best grade of vanadium steel casting for the housing, drop-forging for the gears, phosphor bronze for the pistons and piston blades. The drill spindle runs in ball bearings, eliminating all unnecessary friction and giving the best efficiency for the least consumption of air."

A marine type of refrigerating machine is described in an illustrated catalogue which has just been printed by the Clothel Company, 90 West street, New York. Regarding the company's 3-ton marine machine the catalogue makes the following statement: "On account of the exceedingly small space available for refrigerating machinery on small pleasure yachts we have spent a great deal of time in developing a machine with the idea of using as little floor space is possible. Our efforts have been rewarded by the design of our 'M' type machine. This machine consists of a rotary compressor driven through a flexible coupling and outboard bearing by a Morse silent chain from a variable speed electric motor. The brine and water pumps are driven by gears from a driving gear placed on the main drive shaft. These three gears run in a cast iron oil-tight housing, which precludes any possibility of noise. The chain is incased in an oil-tight sheet metal chain guard. All of this apparatus is mounted on a cast iron bedplate, and all the necessary auxiliary connections are furnished, including suction strainer and lubricant sight feed."

"Link-Belt Silent Chain" is the title of Data Book No. 125 just published by the Link-Belt Company, Chicago, Ill. This is an exceptionally handsome volume of 110 pages, profusely illustrated. Among the uses to which the Link-Belt Company's silent chain may be put is for machine tool drives, in connection with which the following statement is made in the catalogue: "The driving force through a chain, positive but elastic, is equal at each instant to the force required to do the work at the rate of the feed and speed as set, meeting unflinchingly the requirements as they arise. A steady, uniform rate of work is the result. The deflections in the machine parts are held constant, and the tools cut away the metal, as opposed to the tearing and chattering that occur with the shock of high-speed gears, or with the creep and slip of leather belts. Numerous carefully made tests between belt-driven and chain-driven machines give the following average results in favor of the chain drive: Twenty percent greater output; 20 percent saving in power; from four to ten times the service is obtained on cutting tools, with the consequent saving in time of operator for grinding, resetting, etc.; better finish; less wear and tear on bearings and other rotating parts; larger and heavier work may be done on the same machine."

The Seabury watertube boiler, which is used by various departments of the United States Government, is described in Catalogue 10-A, published by the Boiler Department of the Gas Engine & Power Company and Chas. L. Seabury & Company, Con., Morris Heights, N. Y.

The latest publication issued by the Lagonda Manufacturing Company, Springfield, Ohio, is a 24-page bulletin on its triple-acting automatic cut-off valves and non-return valves. This book briefly but completely discusses the function of these valves, and illustrates the several types made by the Lagonda Manufacturing Company, which are the standard angle type and straight-way valve, the low,squat body valve for low head room and the horizontal valve. A copy of this bulletin will be sent to anyone on request.

Bulletin No. 60—The Richardson Model "T" Sight-Feed Oil Pump, recently issued by The Richardson-Phenix Company, Milwaukee, Wis., contains much new information concerning the well-known Model "M" lubricator. Interesting illustrations show the process of manufacture from the raw material to the finished lubricators on the test rack, and give a good idea of the manner in which the pumps are drilled and milled from a solid block of cast iron. An interesting chapter on gas engine lubrication discusses the question of timing the admission of oil so that it is forced directly onto the engine pistons. Other items of interest are a description of the new Richardson air spray attachment; also the steam and electric attachments for heating the oil in the lubricator reservoir. A double-page illustration of the New York skyline shows that practically all important buildings in the metropolitan district are equipped with Richardson-Phenix lubricating appliances. Copies of the above bulletins may be had upon request from the Richardson-Phenix Company.

"Finding and Stopping Waste in Modern Boiler Rooms" is the title of a 68-page book devoted to the use and design of Cochrane meters, issued by the Harrison Safety Boiler Works, Philadelphia, Pa. The value of feed water and condenser meters as aids in the management of power plants is taken up in detail in the introductory part of the book, covering, among other factors, grade of fuel, grates, methods of firing, air leaks, control of draft, condition of gas passages, scale and soot on boiler tubes, radiation, etc. With a feed-water meter installed, it becomes possible to measure the effect of changes in connection with these several factors, the over-all efficiency and economy, and the means and ways of obtaining the desired result having been ascertained, the manager or engineer is in a position to insist upon good results continuously; that is, with facilities for continuous quantitative measurements and records as afforded by this apparatus, scientific management becomes easy and natural, and standard rules of operation, such as directions for handling fires, regulation of draft, blowing of soot, banking of fires, carrying overloads, etc., can be written out, so that any man following them can obtain good results. The use of records further arouses the ambition and spirit of emulation of the men, and makes it possible to reward special skill or attention to duty, as bonuses or promotions. In the subsequent sections of the book the Cochrane metering heater (combined open feed-water heater and hot-water meter), with its several modifications, is described in detail, as also the Cochrane flow recorder, for use in connection with V-notch weirs. In the last pages of the book of a new type of meter, working on the volumetric principle, by means of which it is said to be possible to obtain great accuracy, as within one-third of 1 percent, is described.

Boiler rivets, structural, tank, ship and bridge rivets are described by the S. Severance Manufacturing Company, Glassport, Pa., in a bulletin the company has just issued.

Heavy plates. tank, flange and firebox, also blue annealed steel plates and sheets, are made by Alan Wood Iron & Steel Company, Widener building, Philadelphia, Pa.

Hydraulic tools and equipment of all sorts, such as accumulators, rivets, flanging presses, shears, punches, bulldozers, etc., are made by R. D. Wood & Company, 400 Chestnut street, Philadelphia, Pa., and are described in a bulletin the company has just published.

Boiler makers' tools and machinery, such as vertical and horizontal plate bending rolls, plate straightening rolls, plate planers, flanging clamps, and all types of punches, shears and riveting machines are described in a catalogue published by Wickes Bros., Saginaw, Mich.

Electric arc welding is described in an illustrated bulletin, B-4005, just published by the C & C Electric & Manufacturing Company, Garwood, N. J. According to the C & C Company, "When welded with a C & C outfit your seams will be continuous, uniform throughout and equal in strength to the metal of the sheet. Calking is entirely eliminated and joints may be either lapped or butted as required. Tanks welded with C & C arc welders may be tested to destruction without breaking out at the seams, and pressures of over 5,000 pounds have been applied to our welded joints without leakage or fracture."

"Modern Welded Pipe" is the title of a booklet which has just been issued by the National Tube Company, Frick building, Pittsburg, Pa. In reference to this booklet the National Tube Company makes the following statement: "We have recently issued a booklet, 'Modern Welded Pipe,' which treats of the manufacture, uses and characteristics of tubular products. While this book was not issued for general distribution, we will gladly send a copy to any person whose letterhead or activities would indicate a legitimate use. We will also send on request List No. 5, showing sizes, dimensions, trade customs and specifications."

"Dixon's Graphite Pipe Joint Compounds" is one of the articles published in the October issue of *Graphite,* issued monthly by the Joseph Dixon Crucible Company, Jersey City, N. J. Users of pipe joint compounds will be interested in reading this article, which we reproduce herewith: "The shipping clerk of the Dixon Grease, Paint & Lubricant Works made the remark the other day that it looked very much as though the foreign nations were eating Dixon's Graphite pipe joint compound, owing to the very large shipments that were being made. On looking up our records, we find that the shipping clerk's statement is not without foundation so far as the sales are concerned. Dixon's Graphite pipe joint compound has for the past few years met with a sale in foreign countries several times greater than it has enjoyed in the United States. Whether this is due to greater appreciation of its merits by foreigners, or to a more vigorous sales policy, we cannot say. Dixon's Graphite pipe joint compound is a material absolutely without an equal for putting together all threaded joints. Being much lighter and much greater in bulk than red lead or white lead, it is far more economical to use than either of those materials. Being a lubricant, it enables the pipe fitter to make a joint far tighter, as he can get a quarter or half turn more on his pipe with the graphite compound than he can get with lead compounds. It is also true that, due to the lubricating quality of the graphite compound, the work of the pipe fitter is much easier and he is less tired at night than when he is making use of other forms of compound. The Dixon Company itself makes a large use of its Graphite pipe joint compound. Whenever the engineer opens the B. & W. boilers, every header is coated with Dixon's pipe joint compound. This prevents leakage, prevents sticking, makes the work easier and prevents rusting. Dixon's Graphite pipe joint compound is a material that should be in use in every factory in the land. It should be used in all boiler works, gas companies and wherever there are ground flanges or threaded pipes to be joined. All threaded pipes that are put together with Dixon's Graphite pipe joint compound can be opened any time without fear of breakage or straining of tools."

In the latest number of *Plymouth Products,* published by the Plymouth Cordage Company, North Plymouth, Mass., are a number of interesting photographs showing the use of Plyenough rope in towing jobs. One of these is described as follows: "Imagine a sunken coal barge of 3,000 tons, with its bow resting on bottom in 7 fathoms of water and its stern just barely afloat. Quite a load to haul inshore, you say. Yet jobs like this are all in the day's work of the Thames Tow Boat Company, of New London, Conn., and other such concerns. And uneventful enough, too, when Plymouth manila is used for the hauling. The sunken vessel in our illustration is the Philadelphia & Reading barge *Exeter*. She was sent to the bottom off Narragansett Bay by the steamer *Concord,* and when this picture was snapped was being hauled into shoal water by the New London tug *Paul Jones.* A bridle of 10-inch Plymouth manila was used. At one time during the haul three tugs were pulling together on the bridle and developing a total of 3,000 horsepower. Yes, the New London concern uses Plymouth exclusively."

The Ingersoll-Rand Company, 11 Broadway, New York, N. Y., has issued two new booklets, Forms 76 and 9201. Form 76 is an 80-page catalogue, subject "Water Lifted by Compressed Air." It is a very complete treatise on the Air Lift and explains in thorough detail the air lift system of pumping. To all those in any way interested in adequate water supply a copy of this booklet will be found invaluable, since it very intelligibly presents all the facts essential in analyzing a proposition involving the use of clean water in quantity. Form 9201 is a 128-page 6 x 9 catalogue on Calyx core drills. The principle function of the core drill is the determination of the character, order, thickness and extent of the materials beneath the earth's surface, by means of cylindrical cores which it extracts. In coal and metal mines, stone quarries, contract work or for canal or tunnel developments projected, the core drill is used and takes what is otherwise an unknown quantity and converts it into an absolute certainty. By determining the actual conditions in advance, it is a medium to save thousands of dollars in machine equipment, underground workings, etc., that might otherwise be expended only to find a barren property. Booklet is illustrated, gives size and capacities of the different types and shows the apparatus in operation in the various fields.

"The Cost of Pumping Water" is the title of a collection of graphical charts, with accompanying explanatory text, issued by the De Laval Steam Turbine Company, Trenton, N. J. The object of the publication is to facilitate computation of the over-all economy of different types of steam pumping units, having given the cost of fuel, steam pressure, rate of interest, cost of apparatus and other variables. The first chart shows the number of British thermal units represented by each pound of steam for various combinations of superheat, steam pressure and feed-water temperature. The second chart gives the cost of 1,000 pounds of steam and the cost of a million British thermal units in the steam from the cost of coal per ton, the heat value of the coal and the boiler efficiency. The third diagram shows the relation existing between the average cost of steam-turbine-driven centrifugal pumping units and the head pumped against. The fourth diagram shows the amount of money to be set aside yearly for sinking fund, to cover depreciation for different terms of life and rates of interest. The fifth diagram is the well-known Mollier steam chart, supplemented by a convenient scale, by means of which British thermal units available per pound between given limits, the resulting velocity of steam in feet per second, and the corresponding duty in foot pounds per 1,000 pounds of steam, and the pounds of steam per horsepower-hour may be read off directly. The sixth diagram is an alignment chart for determining the resistance of pipes to flow of water. Three scales represent gallons per minute, diameter of pipe in inches, and loss of head in feet per 1,000 feet of pipe. A straight edge laid across points corresponding to known figures on two of the scales, shows the third variable by intersection with the remaining scale. At the end of the publication a list of representative municipal installations of De Laval steam-turbine-driven centrifugal pumps, from which it is to be observed that units of this type have been installed for capacities as large as 100,000,000 gallons per day and heads as great as 334 feet, and have developed duties exceeding 150,000,000 feet-pounds per 1,000 pounds of steam. It is also pointed out that because of the low first cost of apparatus, foundations and buildings inherent in this type of pump, the total cost of pumping water is greatly reduced as compared with the much larger, heavier and more expensive triple-expansion reciprocating pumping engines, in spite of the somewhat higher duty exhibited by the latter. Copies of the publication are offered gratis to those interested.

"Thor" pneumatic and electric tools are described in a circular just published by the Independent Pneumatic Tool Company, 1307 Michigan avenue, Chicago, Ill. In this circular ten features of "Thor" tools are given as follows: "Corliss valves, roller bearings, telescopic screw feed, removable crank chamber plate, cast steel casing in two parts, and protected valves in air drills; ball and roller bearings and special powerful motor in electric drills; one-piece drop-forged barrel and handle in long-stroke riveting hammers, and new single valve in chipping and calking hammers. The 'Thor' line consists of piston air drills; reversible flue rolling, reaming, tapping and wood-boring machines; close-quarter drills; grinders; pneumatic riveting, chipping, calking and beading hammers; staybolt drivers; pneumatic holders-on; hose and hose couplings; rivet sets and electric drills."

"Salesman-Ship" is the publication issued by the Columbian Rope Company, Auburn, N. Y. From it we take the following: "So many of our friends have spoken of the value of the educational articles which have appeared in *Salesman-Ship* since its inception, that we are going to suggest making your copies into a permanent reference library. To enable all of you who are interested in the study of rope and twines, the fiber used in their manufacture and the method of manufacture, we are offering a binder which can be very easily used for binding a year's issue of our *Salesman-Ship*. Bind your copies of *Salesman-Ship* and make them a permanent source of information. You will find that it is a very excellent way to make sure of retaining copies of all issues for reference purposes. Beginning with the September issue, *Salesman-Ship* was punched with two small holes on the left-hand binding margin, which will enable you to insert them quickly and evenly. The value of this information to you is certainly worth a whole lot more than the price that we have placed on this binder. They will be furnished to any of our friends who wish them for 25 cents each, containing all issues of *Salesman-Ship* up to date. You had better get one *now* while we have an ample supply. Send 25 cents by money order or in postage stamps."

BUSINESS NOTES

Announcement.—The Sprague Electric Works of the General Electric Company has recently opened a sales office in the Provident Bank Building, Cincinnati, Ohio, under the management of Mr. Frank H. Hill. The Cincinnati office has been established to facilitate the prompt and efficient handling of the increasing business in that section.

Late sales of the Brunswick Refrigerating Company, New Brunswick, N. J., are as follows: To Wm. Cramp & Sons, three 2-ton plants, two for the steamers of the Sun Company, now being built, and one for the Petroleum Transport Company's steamer, now being built. This is the third Petroleum Transport steamer to be equipped with Brunswick apparatus. Through the Newport News Shipbuilding & Dry Dock Company orders were received for two 1-ton plants for the Crowell & Thurlow steamers, now being built at Newport News. There are now seven Crowell & Thurlow steamers equipped with Brunswick apparatus. Orders have been given by the New York & Porto Rico Steamship Company for equipping three of their steamers now in service. The plants are installed while the boats are in port between trips, and it is not necessary to delay the sailing of the vessel any while the plant is being put on. The Clinchfield Navigation Company has placed orders for ½-ton plants for their steamers *Clinchfield* and *International*. The Vacuum Oil Company has ordered a 1-ton plant for their steamer *Gargoyle*. Richard Howe has had his yacht *Natoma* equipped with a ½-ton Brunswick plant, cooling two refrigerators. The compressor is operated by a kerosene engine geared to the compressor. In case steam is not always handy, it is possible to use a kerosene or gasoline engine. The Gulf Refining Company has recently placed an order for equipping the steamship *Ligonier* with a 2-ton plant for cooling refrigerators and cooling drinking water. A 2-ton plant was installed on the sister ship *Larimer* a short time ago, and has worked out so satisfactorily that the order for the *Ligonier* has been placed. Data regarding Brunswick marine refrigerating, ice-making and water-cooling plants will be gladly furnished on request by addressing the Brunswick Refrigerating Company, Marine Department, New Brunswick, N. J.

W. R. Haynie, manager of Bolinders Company, 30 Church street, New York, the American office of J. & C. G. Bolinders, Ltd., Stockholm, Sweden, has sailed for Stockholm, to be gone about six weeks. Referring to his trip, Mr. Haynie writes International Marine Engineering as follows: "I am making this trip at the present time with a view of increasing the facilities for delivering the Bolinder marine oil engines in America, where the demand is increasing so rapidly that it is hard to keep up with deliveries. This carries out the position taken by me years ago, which I have stuck to throughout several years of constant effort, viz.: The United States is producing 80 percent of the oil of the world; it is, therefore, the market for oil engines, and in course of time the American industrial interests will realize the value of and adopt the methods—long since in use in Europe—of considering economy before first or initial cost of equipment, meaning that it frequently justifies the owner of a ship or power plant to pay double the initial price for machinery in view of the fact that the economy of the higher cost machinery will more than save itself in total cost within several years' operation."

HELP AND SITUATION AND FOR SALE ADVERTISEMENTS

No advertisements accepted unless cash accompanies the order.

Advertisements will be inserted under this heading at the rate of 4 cents (2 pence) per word for the first insertion. For each subsequent consecutive insertion the charge will be 1 cent (½ penny) per word. But no advertisement will be inserted for less than 75 cents (3 shillings). Replies can be sent to our care if desired, and they will be forwarded without additional charge.

Salesman, aged 28, with nine years' experience in yacht, commercial, vessel brokerage and marine products, wants position. Is well acquainted among shipyards. Address *Salesman*, care of INTERNATIONAL MARINE ENGINEERING, 17 Battery Place, New York.

For Sale—One Knowles Independent air pump and jet condenser, in A-1 condition, size, 10 x 14 x 18. Price, $200. Address *Lake Champlain Transportation Company*, Whitehall, N. Y.

Mechanical Engineer and practical hull constructor competent to take charge of engine or hull department would like to connect with ship or boat building firm desirous of building their own oil engines. I have invented and perfected a marine oil engine suitable for large and medium units. This engine is the outcome of twenty years of experimenting and is developed on different principles from those at present on the market. It starts and controls like a steam engine even as a single cylinder unit without special starting gear and with load on using the low grade fuels. Address **Box 75**, care of INTERNATIONAL MARINE ENGINEERING.

NELSON VALVES at the Panama-Pacific Exposition. The Nelson Valve Company, Philadelphia, Pa., has on display at the exposition an exhibit of valves which has attracted very favorable attention. Its most striking feature is a large revolving black velvet-covered display stand, on which has been arranged a comprehensive assortment of brass valves of various kinds. Included among them are gate, globe, angle, swing check and non-return valves. They have been mounted, so as to afford an excellent opportunity for a close and detailed examination of every feature. In addition a number of sectioned valves of each kind are displayed, so that the internal design may be more easily explained.

MARINE SOCIETIES.

AMERICA.

AMERICAN SOCIETY OF NAVAL ENGINEERS
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS
29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE
Naval Academy, Annapolis, Md.

AMERICAN ASSOCIATION OF MASTERS, MATES AND PILOTS
National President—John H. Pruett, 423 Forty-Ninth St., Brooklyn, N. Y.
National Treasurer—A. B. Devlin, 21 State St., New York.
National Secretary—M. D. Tenniswood, 308 Vine St., Camden, N. J.

THE AMERICAN SOCIETY OF MARINE DRAFTSMEN
President—J. Emile Schmeltzer, 221 Cumberland street, Brooklyn, N. Y.
Vice-President—H. A. Hope, Newport News S. B. & D. D. Co., New port News, Va.
Secretary—B. G. Barnes, 40 Faxon avenue, Quincy, Mass.
Treasurer—P. K. Thurston, Navy Department, Washington, D. C.
Executive Committeeman—P. H. Frohwein, New London, Conn.

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NATIONAL OFFICERS.
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Secretary—Geo. A. Grubb, 1040 Dakin street, Chicago, Ill.
Treasurer—A. L. Jones, 38 Avery avenue, Detroit, Mich.

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Grand Vice-President—A. F. Hamelin, 3210 Letang St., Montreal.
Grand Secretary-Treasurer—Neil J. Morrison, P. O. Box 238, St. John, N. B.

GREAT BRITAIN.

INSTITUTION OF NAVAL ARCHITECTS
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND
39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS
Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORP.
The Minories, Tower Hill, London.

"LEA" V-NOTCH METER in operation at Yarnall-Waring Exposition Exhibit. One of the interesting exhibits in the Palace of Machinery, at the Panama-Pacific Exposition, is that of Yarnall-Waring Company, Philadelphia, Pa. At the front of the exhibition space is a full-sized working "Lea" V-Notch recording liquid meter. Recording instrument, float and V-notch are all complete, as is also the tank, with the exception of the top, which has been removed. Ingenious arrangements have been made, so that the actual operation of the meter may be followed through from start to finish. A centrifugal pump operates the apparatus. It lifts the water to the chamber in front of the V-Notch weir, over which it must pass to be metered. An electric light has been placed under the flow of water over the V. Another light has been placed in the instrument case above the tank, where the recording pen traces the amount of flow over the weir on a chart. An observer may stand in front of the case, and by operating a valve controlling the amount of flow over the weir, watch the action of the recording instrument, just as though it were under actual working conditions.

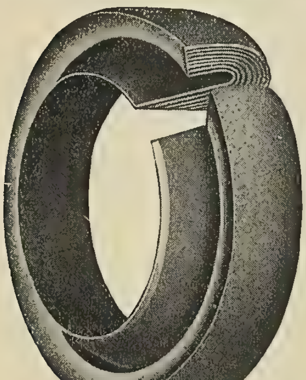
JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

JOHNS-MANVILLE SERVICE

JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

THIS emblem is more than a trade-mark device. It stands for the experience, ability and business integrity of a long-established house. So that any article upon which it appears is not merely offered for sale; it is meant to give service. And that every J-M Product shall give this service fully and permanently, is the whole meaning of J-M Responsibility.

The principle of a Stillson Wrench illustrates the action of J-M Sea Rings on an engine rod.



A Stillson only grips on "one turn" or stroke, so do sea rings on an engine rod. Note how the steam pressure acts against the hollow space shown in the sectional view and how the flexible lip of the ring is forced against the rod. Just as soon as the steam pressure falls the pressure of the lip on the rod decreases.

If you figure out the saving that this makes, you will find that there is just one quarter the wear, one quarter the friction or power lost, few renewals and long life.

J-M Sea Rings will more than pay their own way in your plant. Why not try them out?

The water back of J-M Duplex never gets by. In other words—this packing doesn't leak.

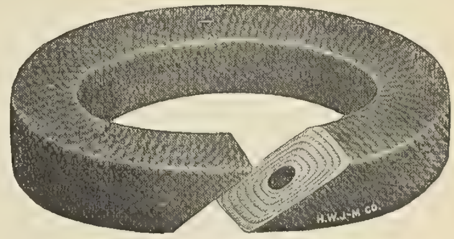
There are only two ways that water can get by a piece of rod packing—past it or through it. If the packing is resilient enough water can't get past it and if it's made like J-M Duplex water can't get through it. Note the large rubber core and layers of cement that make the packing resilient.

Then see how these layers of cement hold back seeping water.

This is why Duplex-packed water boxes are leak-proof.

If you want a surprise on packing life try J-M Duplex.

You'll get tired waiting for it to wear out.



J-M Duplex

H. W. JOHNS-MANVILLE COMPANY

Akron	Boston	Columbus	Duluth	Kansas City	Minneapolis	Philadelphia	St. Paul	Toledo
Albany	Buffalo	Dallas	Galveston	Los Angeles	Newark	Pittsburgh	Salt Lake City	Washington
Atlanta	Chicago	Dayton	Houghton	Louisville	New Orleans	Portland	San Francisco	Wilkes-Barre
Baltimore	Cincinnati	Denver	Houston	Memphis	New York	Rochester	Seattle	Youngstown
Birmingham	Cleveland	Detroit	Indianapolis	Milwaukee	Omaha	St. Louis	Syracuse	

THE CANADIAN H. W. JOHNS-MANVILLE CO., LTD., Toronto, Winnipeg, Montreal, Vancouver

Main Steering Gear for the U. S. Battleship

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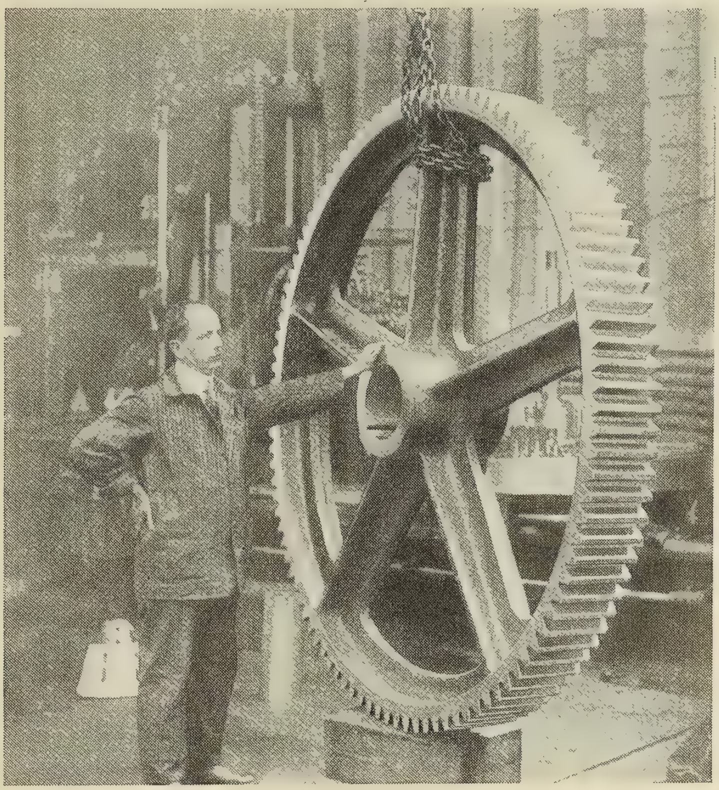

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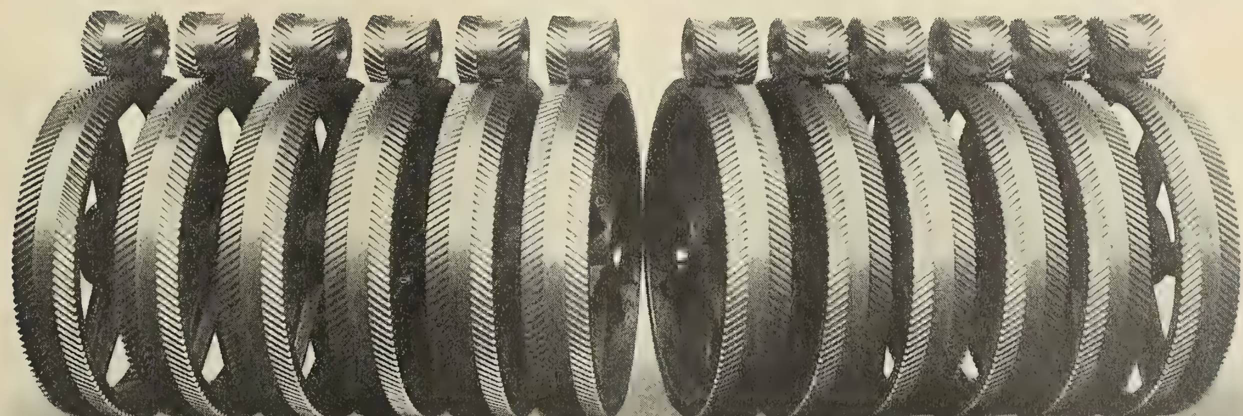

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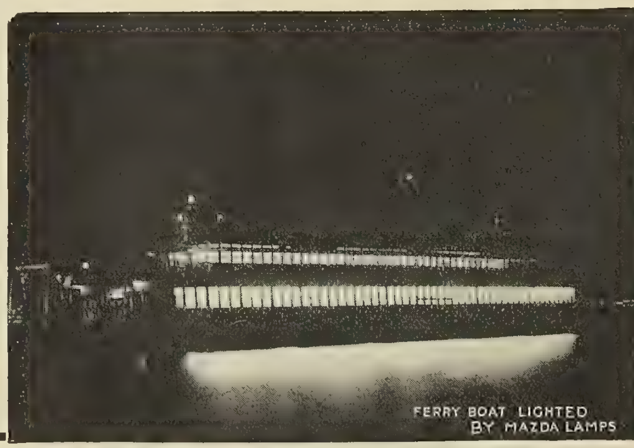

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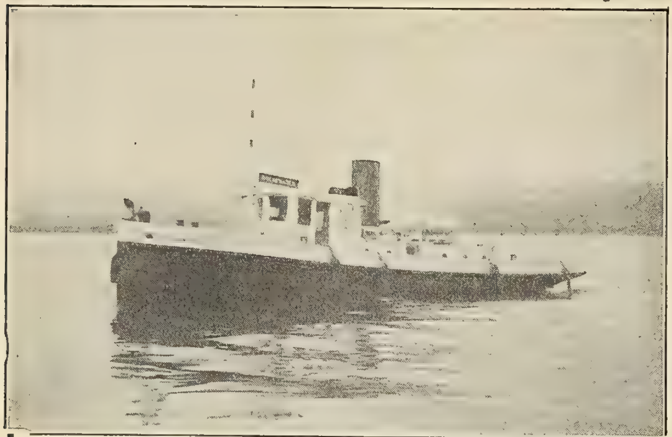

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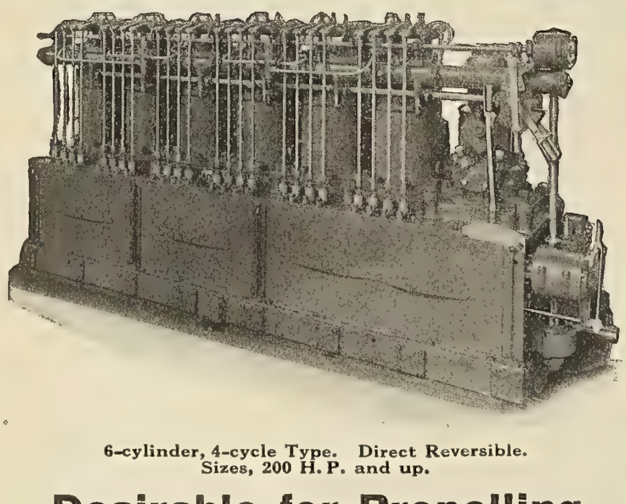

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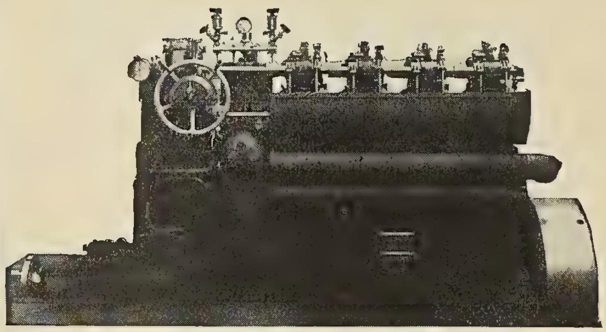

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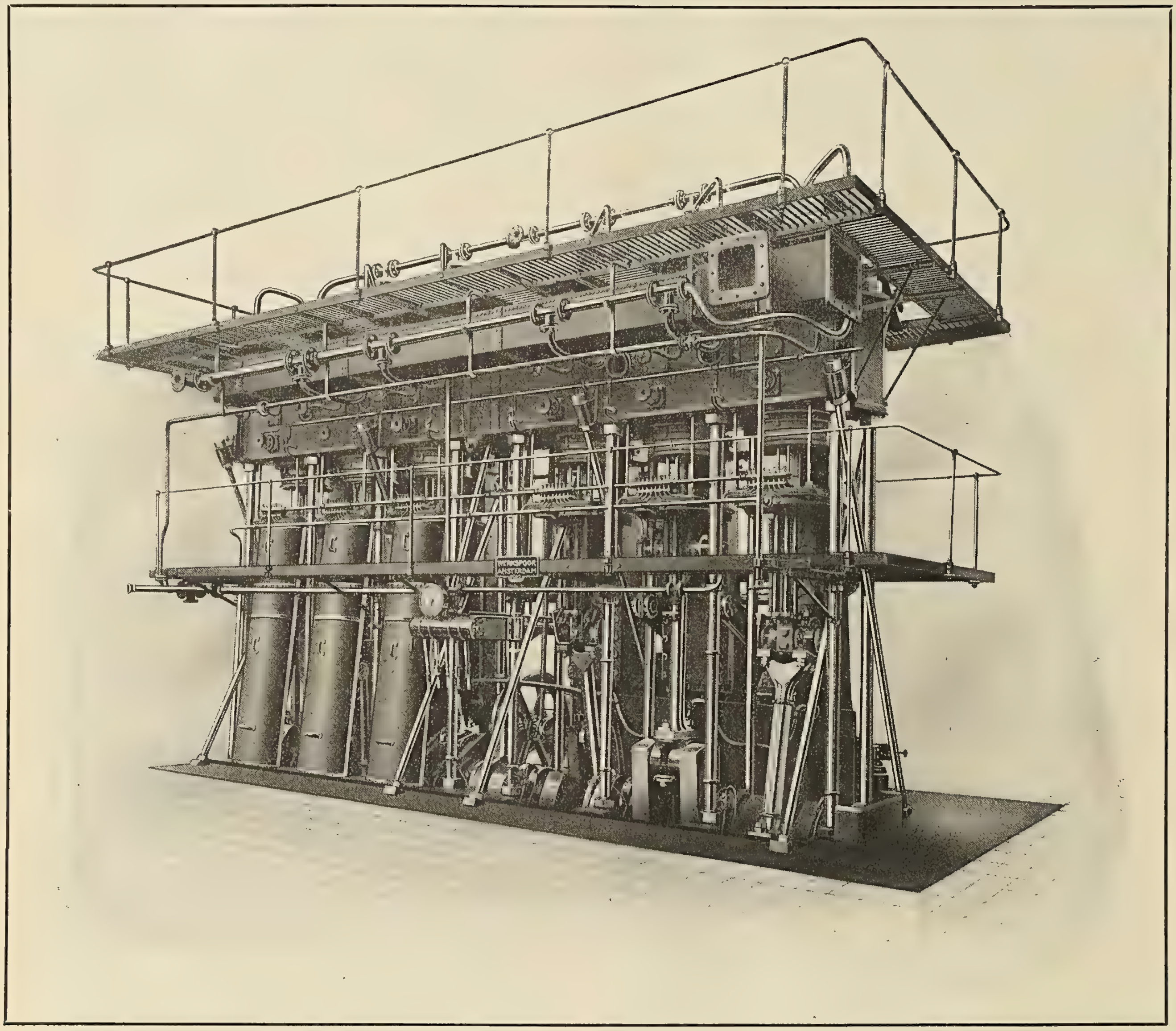

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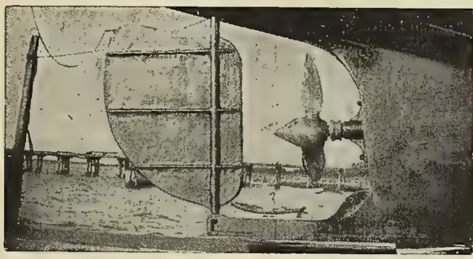

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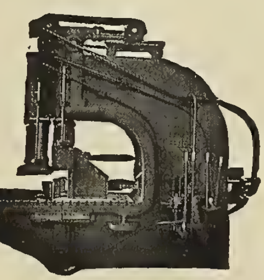

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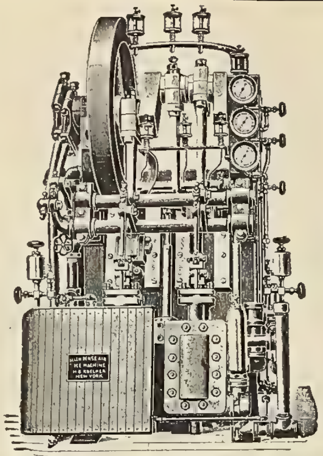

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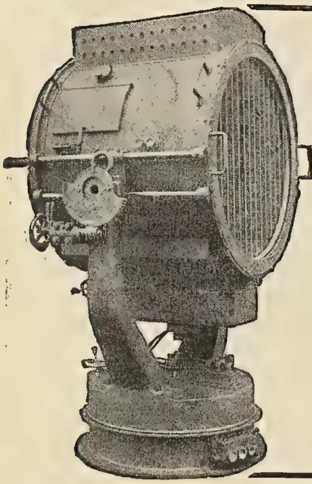

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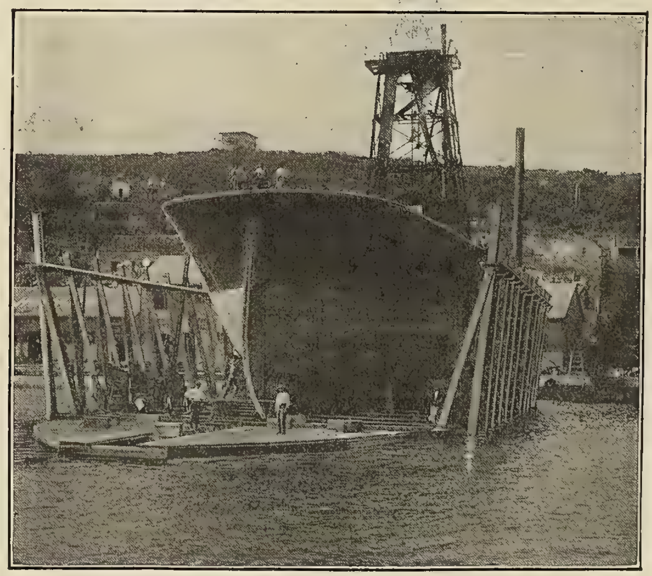

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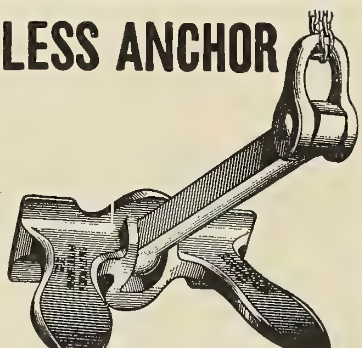

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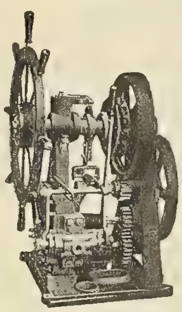

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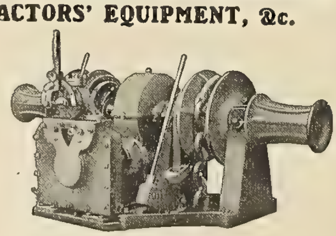

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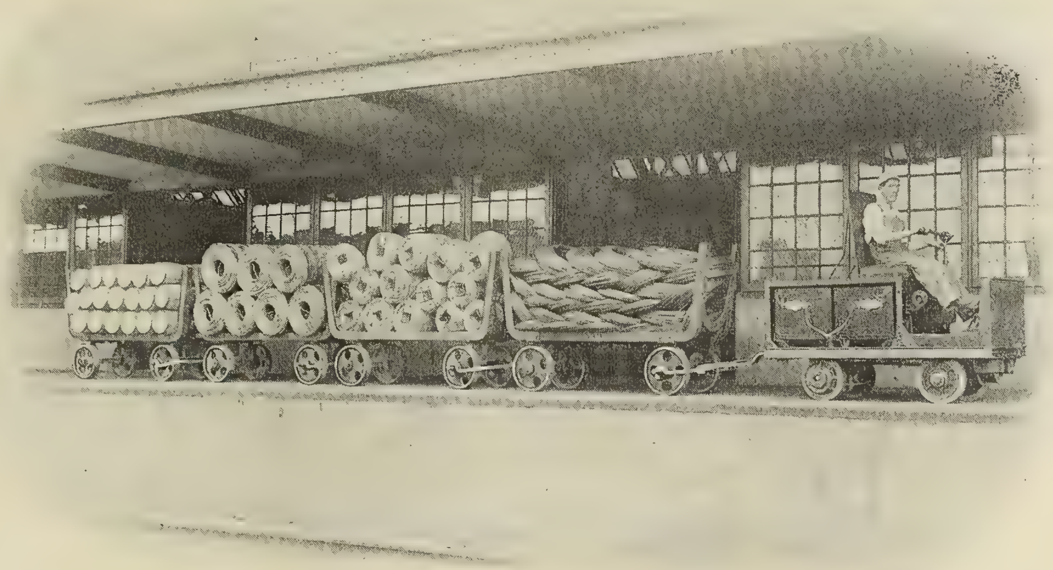

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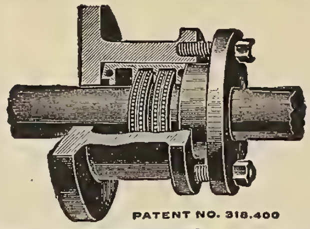

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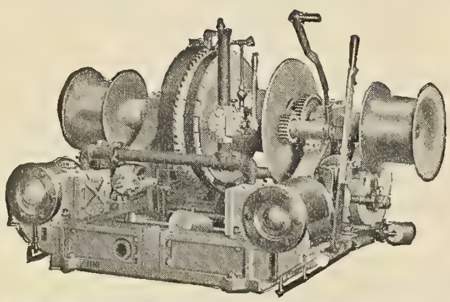

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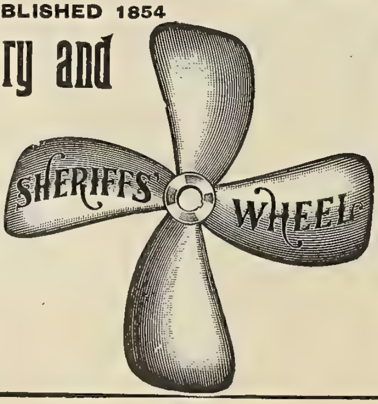

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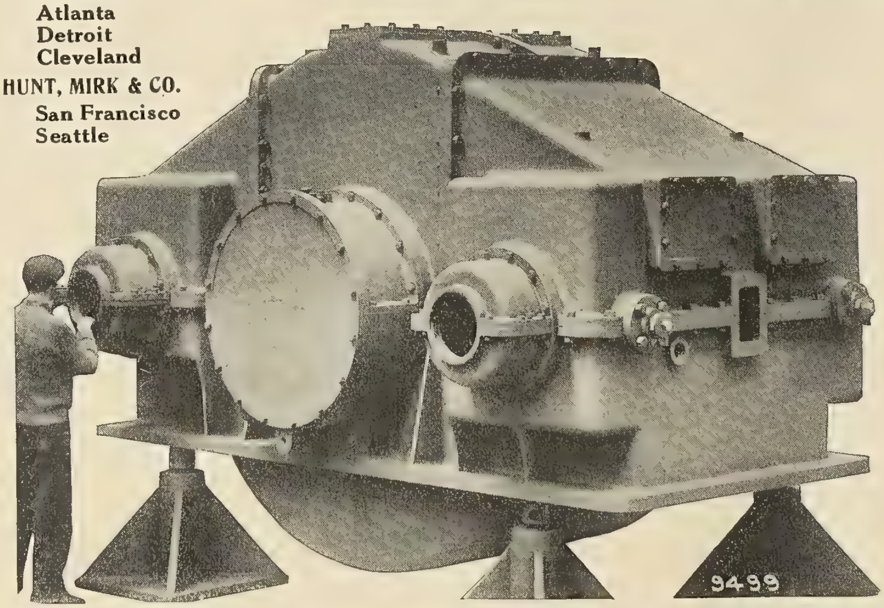

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FIREPROOF CONSTRUCTION, ROOFING, SHINGLES, LATH AND OTHER FIREPROOF BUILDING MATERIAL.
Asbestos Protected Metal Co., Beaver Falls, Pa.
Johns-Manville Co., H. W., New York.

FIREPROOF LUMBER—See LUMBER, FIREPROOF.

FIRE PUMPS—See PUMPS.

FLANGES.
Dart, E. M., Mfg. Co., Providence, R. I.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

FLANGING PRESSES.
Niles-Bement-Pond Co., New York.

FLOATING DRY DOCKS—See DRY DOCKS.

FLUE CLEANERS—See BOILER FLUE CLEANERS.

FLUE CUTTERS—See BOILER FLUE AND TUBE CUTTERS.

FORCED DRAFT—See also BLOWERS.
American Blower Co., Detroit, Mich.
De Laval Steam Turbine Co., Trenton, N. J.
General Electric Co., Schenectady, N. Y.
Kerr Turbine Co., Wellsville, N. J.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford, Conn.
Westinghouse Machine Co., East Pittsburgh, Pa.

FORGES.
Sturtevant Co., B. F., Hyde Park, Mass.

FORGINGS, BRONZE—See also DROP FORGINGS.
Hyde Windlass Co., Bath, Me.

FORGINGS, IRON AND STEEL.
Valk & Murdoch Co., Charleston, S. C.
Weimer Chain & Iron Co., Lebanon, Pa.

FREIGHT-HANDLING EQUIPMENT.
Box & Co., Alfred, Philadelphia, Pa.
Elwell-Parker Electric Co., Cleveland, Ohio.
McMyler-Interstate Co., The, Cleveland, Ohio.
Sprague Electric Works, New York.

FRIGIDOMETERS.
McNab Co., The, Bridgeport, Conn.

FROSTPROOF COVERINGS.
Ferdinand, L. W., & Co., Boston, Mass.
Johns-Manville Co., H. W., New York.

FUEL ECONOMIZERS.
Griscom-Russell Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

FUEL OIL BURNERS.
Schutte & Körting Co., Philadelphia, Pa.

FURNACE FRONTS—MARINE AND STATIONARY.
Continental Iron Works, The, Brooklyn, N. Y.
Fletcher, W. & A., Co., Hoboken, N. J.

FURNACES—Also see CORRUGATED FURNACES.
Continental Iron Works, The, Brooklyn, N. Y.
FUSIBLE PLUGS.
Griscom-Russell Co., New York.
Johns-Manville Co., H. W., New York.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
Williams Valve Co., D. T., Cincinnati, Ohio.
GALLEYS—See RANGES.
GAS BLOWERS AND EXHAUSTERS.
American Blower Co., Detroit, Mich.
Schutte & Körting Co., Philadelphia, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
GASKETS—Also see PACKING.
Griscom-Russell Co., New York.
Johns-Manville, H. W., Co., New York.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Smooth-On Mfg. Co., Jersey City, N. J.
GASOLINE ENGINES—Also see LAUNCHES AND YACHTS. KEROSENE ENGINES; OIL ENGINES; DIESEL ENGINES.
Bridgeport Motor Co., Bridgeport, Conn.
Gas Engine & Power Co., and Chas. L. Seabury & Co., Consol., Morris Heights, N. Y.
Standard Motor Construction Co., Jersey City, N. J.
Wolverine Motor Works, Bridgeport, Conn.
GAS ENGINE SPECIALTIES.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburgh, Pa.
Powell, Wm., Co., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.
GAS PRODUCERS—See MARINE GAS PRODUCERS.
GATE VALVES—See VALVES.
GAUGE COCKS.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.
Powell, Wm., Co., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.
GAUGES—See STEAM GAUGES; also WATER GAUGES.
GAUGE GLASSES.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Williams Valve Co., D. T., Cincinnati, Ohio.
GENERATORS—See ELECTRIC PLANTS.
GLOBE VALVES—See VALVES.
GLUE—LINOLEUM, MARINE, SHIP, YACHT, WATERPROOF.
Ferdinand, L. W., & Co., Boston, Mass.
GLUE POTS—ELECTRIC.
Simplex Electric Heating Co., Cambridge, Mass.
GOVERNORS—See PUMP GOVERNORS.
GRABS—See DREDGING MACHINES.
GRAPHITE.
Dixon, Jos., Crucible Co., Jersey City, N. J.
GRATE BARS.
Griscom-Russell Co., New York.
GREASE—See LUBRICANTS—also see LAUNCHING GREASE.
GREASE CUPS—See LUBRICATORS.
Albany Lubricating Co., New York.
Griscom-Russell Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
GREASE EXTRACTORS.
Griscom-Russell Co., New York.
GYPSEYS.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.
HAMMERS, PNEUMATIC—See PNEUMATIC TOOLS.
HAMMERS, STEAM—See STEAM HAMMERS.
HAMMOCKS—See COUCH HAMMOCKS.
HARDWARE—See MARINE HARDWARE.
HARDWOOD—See LUMBER.
HAWSERS—See WIRE ROPE.
HEATERS—BATH, LAVATORY, SHOWER.
Alberger Pump and Condenser Co., New York.
Mott Iron Works, J. L., New York.
Sands, A. B., & Son Co., New York.
Schutte & Körting Co., Philadelphia, Pa.
HEATING AND VENTILATING APPARATUS.
American Blower Co., Detroit, Mich.
Schutte & Körting Co., Philadelphia, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
HEMP—See TWINE.
HOISTING ENGINES.
American Engineering Co., Philadelphia, Pa.
Dake Engine Co., Grand Haven, Mich.
Hyde Windlass Co., Bath, Maine.
Lidgerwood Mfg. Co., New York.
HOISTS CHAIN—See CHAIN HOISTS.
HOISTS, ELECTRIC—See ELECTRIC HOISTS.
HOSE—See AIR HOSE.
Eureka Fire Hose Mfg. Co., New York.
Independent Pneumatic Tool Co., Chicago and New York.
Johns-Manville Co., H. W., New York.
New York Belting & Packing Co., New York.
HOSE COUPLING.
Cleveland Pneumatic Tool Co., Cleveland, Ohio.
Eureka Fire Hose Mfg. Co., New York.
Independent Pneumatic Tool Co., Chicago and New York.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.

HOSE NOZZLES.
McNab & Harlin Mfg. Co., New York.
Morse, Andrew J., Son, Inc., Boston, Mass.

HUMIDIFIERS.
Griscom-Russell Co., New York.

HYDRAULIC FITTINGS.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.
Powell, Wm., Co., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

HYDRAULIC MACHINERY—RIVETERS, PUNCHES, SHEARS.
Chambersburg Engineering Co., Chambersburg, Pa.
Niles-Bement-Pond Co., New York.

ICE DETECTORS.
McNab Co., The, Bridgeport, Conn.

ICE MACHINES—See REFRIGERATING PLANTS.

INDICATOR CONNECTIONS.
Lunkenheimer Co., Cincinnati, Ohio.

INDICATORS—STEAM AND GAS ENGINE—Also see DIRECTION AND REVOLUTION INDICATORS.—Also RUDDER POSITION INDICATORS.
Ashton Valve Co., Boston, Mass.
Johns-Manville Co., H. W., New York.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
Powell Co., The, Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

INDUCED DRAFT.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

INJECTORS.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., The, Wm., Cincinnati, Ohio.
Schutte & Korting Co., Philadelphia, Pa.

INTERLOCKING RUBBER TILING.
Griscom-Russell Co., New York.
New York Belting & Packing Co., New York.

IRON CEMENT.
Johns-Manville Co., H. W., New York.
Smooth-On Mfg. Co., Jersey City, N. J.

IRON AND STEEL CORRUGATED PLATES AND SHAPES, ASBESTOS PROTECTED.
Asbestos Protected Metal Co., Beaver Falls, Pa.

JACKS—PNEUMATIC.
Independent Pneumatic Tool Co., Chicago and New York.

JOURNAL BEARINGS—See THRUST BEARINGS.

JUTE.
Columbian Rope Co., Auburn and New York.

KEROSENE ENGINES—See also OIL ENGINES, DIESEL ENGINES AND GASOLINE ENGINES.
Gas Engine & Power Co., and Chas. L. Seabury & Co., Consol., Morris Heights, N. Y.
Mietz Machine Works, August, New York.
Standard Motor Construction Co., Jersey City, N. J.
Wolverine Motor Works, Bridgeport, Conn.

LAGOLINE FOR ENGINE ROOMS
Holzapfels American Compositions Co., New York.

LAMPS, SIGNALS, AND FIXTURES.
General Electric Co., Schenectady, N. Y.
Johns-Manville, H. W., Co., New York.

LATH, ASBESTOS.
Asbestos Protected Metal Co., Beaver Falls, Pa.
Johns-Manville Co., H. W., New York.

LATH, METAL.
Asbestos Protected Metal Co., Beaver Falls, Pa.

LATHES, CRANK SHAFT.
Niles-Bement-Pond Co., New York.

LATHES, ENGINE.
Niles-Bement-Pond Co., New York.

LATHES, TURRET.
Niles-Bement-Pond Co., New York.

LAUNCHES AND YACHTS—See also SHIPBUILDERS AND DRY DOCK COMPANIES AND DREDGES.
Baltimore Dry Docks and Shipbuilding Co., Baltimore, Md.
Bridgeport Motor Co., Bridgeport, Conn.
Gas Engine & Power Co., and Chas. L. Seabury & Co., Consol., Morris Heights, N. Y.
New London Ship & Engine Co., Groton, Conn.
Standard Motor Construction Co., Jersey City, N. J.
Valk & Murdoch Co., Charleston, S. C.
Ward, Chas., Engineering Works, Charleston, W. Va.
Welin Marine Equipment Co., Long Island City, N. Y.
Wolverine Motor Works, Bridgeport, Conn.

LAVATORIES—FOLDING, STATIONARY, STATEROOM.
Mott Iron Works, J. L., New York.
Sands, A. B., & Son Co., New York.

LAVATORY AND BATH HEATERS.
Griscom-Russell Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

LIFE BOATS AND RAFTS.
Lane Life Boat Co., C. M., Brooklyn, N. Y.
Welin Marine Equipment Co., Long Island City, N. Y.

LIFE PRESERVERS.
Ferdinand, L. W., & Co., Boston, Mass.
Welin Marine Equipment Co., Long Island City, N. Y.

LIFE-SAVING DEVICES.
Steward, Robert Bruce, New York.
Welin Marine Equipment Co., Long Island City, N. Y.

LINOLEUM CEMENT.
Ferdinand, L. W., & Co., Boston, Mass.

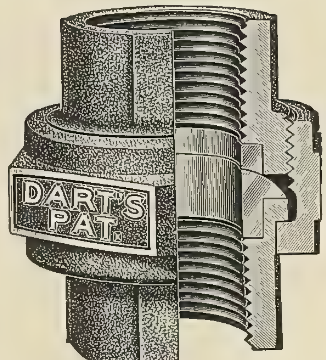
LIQUID GLUE, WATERPROOF.
Ferdinand, L. W., & Co., Boston, Mass.

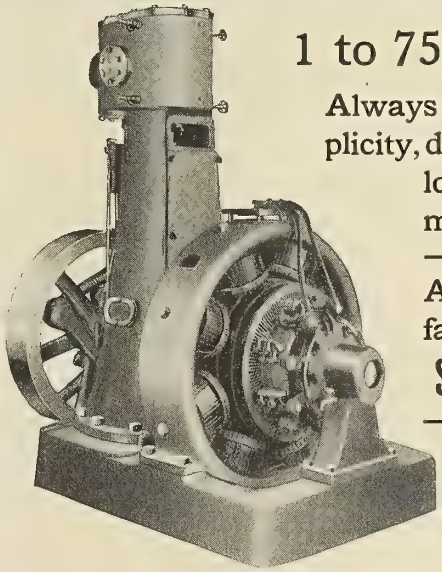
LOCOMOTIVE CRANES—See CRANES.

LOG REGISTERS.
Cummings Ship Instrument Works, Boston, Mass.
McNab Co., The, Bridgeport, Conn.
Welin Marine Equipment Co., Long Island City, N. Y.

LUBRICANTS.
Albany Lubricating Co., New York.
Dixon, Jos., Crucible Co., Jersey City, N. J.

LUBRICATING COMPOUND.
Albany Lubricating Co., New York.
LUBRICATORS.
Albany Lubricating Co., New York.
Griscom-Russell Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
Powell, Wm., Co., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.
LUMBER.
Smith Lumber Co., C. A., Oakland, Cal.
LUMBER—FIREPROOF.
Johns-Manville Co., H. W., New York.
MACHINE TOOLS—See TOOLS, MACHINE.
MAHOGANY—See LUMBER.
MANGANESE BRONZE CASTINGS—Also see BRONZE.
Griscom-Russell Co., New York.
Hyde Windlass Co., Bath, Maine.
Lunkenheimer Co., Cincinnati, Ohio.
MAGNESIA COVERINGS.
Johns-Manville, H. W., Co., New York.
MANILA AND SISAL ROPE—See ROPE; also CORDAGE.
MARINE BOILER COMPOUNDS—See BOILER COMPOUNDS.
MARINE CABLEWAYS.
Lidgerwood Mfg. Co., New York.
MARINE ELECTRICIANS—See ELECTRIC PLANTS.
MARINE ENGINES—See ENGINES, PROPELLING.
MARINE ENGINEERS—See PROFESSIONAL CARDS.
MARINE FORGINGS—See FORGINGS.
MARINE GAS PRODUCERS.
Griscom-Russell Co., New York.
MARINE GLUE.
Ferdinand, L. W., & Co., Boston, Mass.
MARINE HARDWARE.
Ferdinand, L. W., & Co., Boston, Mass.
Gas Engine & Power Co., and Chas. L. Seabury & Co., Consol., Morris Heights, N. Y.
Griscom-Russell Co., New York.
MARINE LAMPS—See LAMPS.
MARINE PAINT—Also see PAINT.
Holzapfels American Compositions Co., New York.
MARINE PLUMBING.
Mott Iron Works, J. L., New York.
Sands, A. B., & Son Co., New York.
MARINE RAILWAY BUILDERS—See RAILWAY DRY DOCKS.
Crandall Engineering Co., The, East Boston, Mass.
MARINE RAILWAYS—See DRY DOCKS AND MARINE RAILWAYS.
MARINE RANGES—See RANGES.
MARINE REPAIRS—See SHIPBUILDERS AND DRY DOCK COMPANIES.
MARINE REFRIGERATION—See REFRIGERATING PLANTS.
MARINE SIGNALS—See SIGNALS.
MARINE SUPERHEATERS.
Babcock & Wilcox Co., New York.
Locomotive Superheater Co., New York.
MARINE SUPPLIES.
Ferdinand, L. W., & Co., Boston, Mass.
MASTS, STEEL.
Welin Marine Equipment Co., Long Island City, N. Y.
MECHANICAL DRAFT.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.
MEGAPHONES—See CHANDLERY STORES.
METAL, ASBESTOS-PROTECTED.
Asbestos Protected Metal Co., Beaver Falls, Pa.
METAL BERTHS, BEDS AND SPRINGS.
Bernstein Mfg Co., Philadelphia, Pa.
Southern Bedding Company, Baltimore, Md.
METAL WORKING TOOLS—See TOOLS, MACHINE.
METALLIC PACKING—Also see PACKING.
France Packing Co., Philadelphia, Pa.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Johns-Manville, H. W., Co., New York.
United States Metallic Packing Co., Philadelphia, Pa.
METRES, ELECTRIC.
General Electric Co., Schenectady, N. Y.
Weston Electrical Instrument Co., Waverly Park, Newark, N. J.
MILLING MACHINES.
Niles-Bement-Pond Co., New York.
MINERAL WOOL—See NON-CONDUCTING COVERING.
MONITOR NOZZLES—See HOSE NOZZLES.
MOORING ENGINES.
American Engineering Co., Philadelphia, Pa.
Dake Engine Co., Grand Haven, Mich.
Hyde Windlass Co., Bath, Maine.
MOTOR BOATS—See LAUNCHES AND YACHTS.
MOTOR BOAT SUPPLIES.
Ferdinand, L. W., & Co., Boston, Mass.
Johns-Manville Co., H. W., New York.
MOTORS, ELECTRIC.
General Electric Co., Schenectady, N. Y.
MOTORS, GASOLINE—See GASOLINE ENGINES.
MULTIPLE DRILLS.
Niles-Bement-Pond Co., New York.
NAVAL ARCHITECTS—See PROFESSIONAL CARDS.
NEEDLE VALVES—See VALVES.
NIPPLES.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.
NON-CONDUCTING COVERING.
Johns-Manville, H. W., Co., New York.
NOZZLES—See HOSE NOZZLES.
NUTS—See BOLTS AND NUTS.





OAKUM.
Baltimore Oakum Co., Baltimore, Md.
Welin Marine Equipment Co., Long Island City, N. Y.
OIL—See LUBRICANTS.
OIL BURNERS, FUEL—See FUEL OIL BURNERS.
OIL CUPS—See LUBRICATORS.
OIL ENGINES—See ENGINES, OIL.
OIL ERADICATORS—FROM FEED-WATER.
Andrews, William, Inc., New York.
OIL FUEL APPARATUS.
Schutte & Körting Co., Philadelphia, Pa.
OIL GAUGES.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
Powell Co., The, Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.
OIL PUMPS.
Lunkenheimer Co., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.
OILING SYSTEMS—Also see LUBRICATORS.
Albany Lubricating Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., Wm., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.
ORANGE PEEL BUCKETS—See DREDGING MACHINERY.
ORE DOCKS—See DOCKS.
ORE HANDLING MACHINERY.
McMyler-Interstate Co., The, Cleveland, Ohio.
PACKING—Also see METALLIC PACKING.
France Packing Co., Philadelphia, Pa.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Johns-Manville, H. W., Co., New York.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
United States Metallic Packing Co., Philadelphia, Pa.
PACKING, ASBESTOS.
Johns-Manville, H. W., Co., New York.
PAINT—Also see GRAPHITE.
Dixon, Jos., Crucible Co., Jersey City, N. J.
Holzapfels American Compositions Co., New York.
Johns-Manville Co., H. W., New York.
PATENT ATTORNEYS—See ATTORNEYS, PATENT.
PENCILS.
American Lead Pencil Co., New York.
Dixon Crucible Co., Joseph, Jersey City, N. J.
PHOSPHOR BRONZE CASTINGS.
Griscom-Russell Co., New York.
Hyde Windlass Co., Bath, Maine.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
PILE DRIVERS.
McMyler-Interstate Co., The, Cleveland, Ohio.
PIPE COVERING—See NON-CONDUCTING COVERING.
PIPE CUTTING AND THREADING MACHINES.
Niles-Bement-Pond Co., New York.
Oster Mfg. Co., Cleveland, Ohio.
PIPE FLANGES—See FLANGES.
PIPE UNIONS.
Dart, E. M., Mfg. Co., Providence, R. I.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.
Powell Co., The, Wm., Cincinnati, Ohio.
Williams Valve Co., D. T., Cincinnati, Ohio.
PIPE WRENCHES.
Williams & Co., J. H., Brooklyn, N. Y.
PLANERS, STANDARD METAL WORKING AND ROTARY.
Niles-Bement-Pond Co., New York.
PLANERS, SHIP PLATE.
Niles-Bement-Pond Co., New York.
PLANIMETERS.
Star Brass Mfg. Co., Boston, Mass.
PLATE-BENDING ROLLS.
Niles-Bement-Pond Co., New York.
PLUMBAGO—Also see GRAPHITE.
Dixon, Jos., Crucible Co., Jersey City, N. J.
PLUMBING—See MARINE PLUMBING.
PNEUMATIC SEPARATORS.
Griscom-Russell Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
PNEUMATIC TOOLS
Cleveland Pneumatic Tool Co., Cleveland, Ohio.
Independent Pneumatic Tool Co., Chicago and New York.
POPPET VALVES—See VALVES.
PORTABLE CYLINDER BORING BARS—See CYLINDER BORING BARS.
PORTABLE DRILLS.
General Electric Co., Schenectady, N. Y.
POWER PUNCHES AND SHEARS—See TOOLS, MACHINE.
PRESSURE REGULATORS.
Ashton Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.
PRODUCERS—See MARINE GAS PRODUCERS.
PROFESSIONAL CARDS.
Cox & Stevens, New York.
Decker, Delbert H., Millerton, N. Y.
Donnelly, W. T., New York.
Farley, Edward P., Co., Chicago, Ill.
Hough, Edward S., San Francisco, Cal.
Watts, J. Murray, Philadelphia, Pa.
PROJECTORS—See SEARCHLIGHTS.

PROPELLER WHEELS.
- Donnelly, W. T., New York.
- Gas Engine & Power Co., and Chas. L. Seabury & Co., Consol., Morris Heights, N. Y.
- Hyde Windlass Co., Bath, Me.
- Sheriffs Mfg. Co., Milwaukee, Wis.
- Trout, H. G., Co., Buffalo, N. Y.
- Watts, J. Murray, Philadelphia, Pa.

PROPELLING ENGINES—See ENGINES, PROPELLING.

PUMPING MACHINERY—SEE ENGINES, PUMPING.

PUMPS—ALSO SEE BOILER FEED PUMPS, AND ENGINES, PUMPING.
- Alberger Pump and Condenser Co., New York.
- Blake & Knowles Steam Pump Works, New York.
- Davidson, M. T., Co., New York.
- De Laval Steam Turbine Co., Trenton, N. J.
- Griscom-Russell Co., New York.
- Hyde Windlass Co., Bath, Maine.
- Kerr Turbine Co., Wellsville, N. Y.
- Sands, A. B., & Son Co., New York.
- Sturtevant Co., B. F., Hyde Park, Mass.
- Terry Steam Turbine Co., Hartford, Conn.
- Westinghouse Machine Co., East Pittsburgh, Pa.

PUMPS, BILGE—See BILGE PUMPS.

PUMPS—BOILER FEED.

PUMPS, DREDGING.
- Terry Steam Turbine Co., Hartford, Conn.

PUNCHING MACHINES AND SHEARING MACHINES, HYDRAULIC POWER AND HAND.
- Niles-Bement-Pond Co., New York.

PYROMETERS.
- Taylor Instrument Companies, Rochester, N. Y.

QUADRANT DAVITS—See DAVITS.

RAFTS—See LIFE BOATS AND RAFTS.

RAILWAY DRY DOCKS.
- Crandall Engineering Co., East Boston, Mass.

RANGE FINDERS.
- Cummings Ship Instrument Works, Boston, Mass.
- McNab Co., The, Bridgeport, Conn.

RANGES.
- Sands, A. B., & Son Co., New York.
- Simplex Electric Heating Co., Cambridge, Mass.

RASPS.
- Nicholson File Co., Providence, R. I.

REAMERS.
- Morse Twist Drill & Machine Co., New Bedford, Mass.

REAMERS—PNEUMATIC.
- Independent Pneumatic Tool Co., Chicago and New York.

REDUCING VALVES—See VALVES.

REFLEX WATER GAUGES.
- Jerguson Gage & Valve Co., Boston, Mass.

REFRIGERATING ENGINEERS—See ENGINEERS, CONSULTING.

REFRIGERATING MACHINERY.
- Brunswick Refrigerating Co., New Brunswick, N. J.
- Clothel Co., The, New York.
- Johns-Manville Co., H. W., New York.
- Kroeschell Bros. Ice Machine Co., Chicago, Ill.
- Roelker, H. B., New York.

REGRINDING VALVES—See VALVES.

RELEASING GEAR.
- Welin Marine Equipment Co., Long Island City, N. Y.

RELIEF VALVES—See VALVES.

RESEATING MACHINES—See VALVE RESEATING MACHINES.

REVOLUTION COUNTERS.
- Ashton Valve Co., Boston, Mass.
- McNab Co., The, Bridgeport, Conn.

RHEOSTATS.
- General Electric Co., Schenectady, N. Y.
- Simplex Electric Heating Co., Cambridge, Mass.

RIGGING—See ROPE, also WIRE ROPE.

RIVER BOATS—Also see SHIPBUILDERS AND DRY DOCK COS.
- Fletcher, W. & A., Co., Hoboken, N. J.
- Gas Engine & Power Co., and Chas. L. Seabury & Co., Consol., Morris Heights, N. Y.
- Merrill-Stevens Co., Jacksonville, Fla.
- New London Ship & Engine Co., Groton, Conn.
- Ward, Chas., Engineering Works, Charleston, W. Va.

RIVETING MACHINES, HYDRAULIC AND STEAM POWER.
- Independent Pneumatic Tool Co., Chicago and New York.
- Niles-Bement-Pond Co., New York.

RIVETERS, PNEUMATIC.
- Independent Pneumatic Tool Co., Chicago and New York.

ROLLER BEARINGS—See THRUST BEARINGS.

ROOFING, FIREPROOF—See FIREPROOF CONSTRUCTION.

ROOFERS' SUPPLIES.
- Asbestos Protected Metal Co., Beaver Falls, Pa.
- Johns-Manville Co., H. W., New York.

ROLLS, BENDING AND STRAIGHTENING.
- Niles-Bement-Pond Co., New York.

ROOFING PAINTS.
- Dixon, Joseph, Crucible Co., Jersey City, N. J.
- Ferdinand, L. W., & Co., Boston, Mass.
- Holzapfels American Compositions Co., New York.
- Johns-Manville Co., H. W., New York.

ROPE—Also see WIRE ROPE and MANILA and SISAL ROPE.
- Columbian Rope Co., Auburn and New York.
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Seattle Construction & Dry Dock Co., Seattle, Wash.
Tietjen & Lang Dry Dock Co., Hoboken, N. J.
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Schutte & Körting Co., Philadelphia, Pa.
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Williams Valve Co., D. T., Cincinnati, Ohio.

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Williams Valve Co., D. T., Cincinatti, Ohio.

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General Electric Co., Schenectady, N. Y.
Westinghouse Machine Co., East Pittsburgh, Pa.

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Bantam Anti-Friction Co., Bantam, Conn.

STEEL PIPE.
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Lidgerwood Mfg. Co., New York.
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TANKS, WELDED STEEL.
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TOWING MACHINES.
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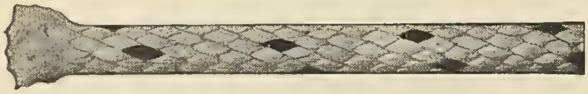

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- American Engineering Co., Philadelphia, Pa.

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- Griscom-Russell Co., New York.
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- Jerguson Gage & Valve Co., Boston, Mass.
- Lunkenheimer Co., Cincinnati, Ohio.
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- Williams Valve Co., D. T., Cincinnati, Ohio.

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- Ferdinand, L. W., & Co., Boston, Mass.
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- American Engineering Co., Philadelphia, Pa.

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- Ashton Valve Co., Boston, Mass.
- Lunkenheimer Co., Cincinnati, Ohio.
- McNab & Harlin Mfg. Co., New York.
- Powell Co., The Wm., Cincinnati, Ohio.
- Star Brass Mfg. Co., Boston, Mass.

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- Griscom-Russell Co., New York.

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- Lidgerwood Mfg. Co., New York.

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